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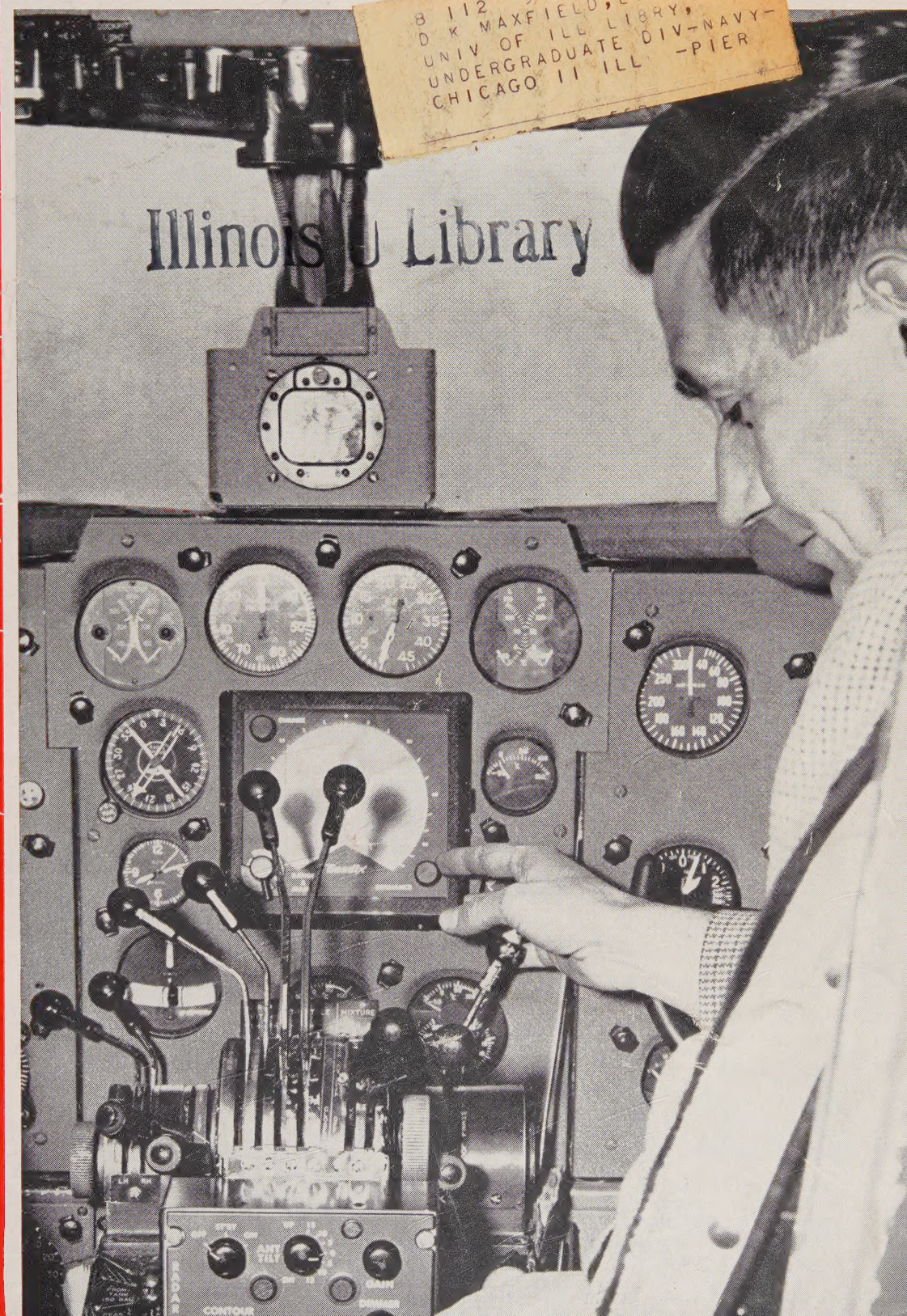

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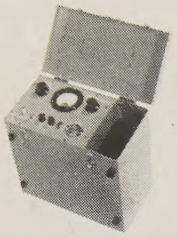
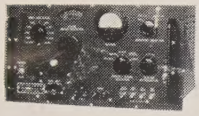


478A-1 ZIFOR

Collins Zero Indicator for Omni-Range is used for ascertaining the proper zero (North) on VOR audio signal generators and checking the phasing of R.F. Signal generator modulators. Modern circuit design results in negligible drift and low setup time. Portable, only two controls to adjust, it is simple in operation with no internal calibration required.

SENSITIVITY: Signals: 0° ±0.6° gives full indications
ACCURACY: ±0.1 degree
PHYSICAL: 13½" w, 13½" h, 7½" d. Wt. Approx. 21 lbs.



479S-3 GENERATOR

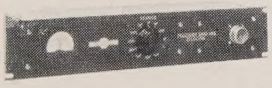
Provides all signals for audio investigations of VOR, tone localizer and glide slope circuits. Designed for rugged simplicity — employing electro-mechanical generators which eliminate the use of tubes. All outputs at levels up to 3 volts.

FREQUENCY STABILITY: Proportional to the frequency stability of 60 cps line
STABILITY: ±0.2% of preset level
PHYSICAL: 19" w, 10½" h, 14" d. Wt. Approx. 88 lbs.

479T-2 GENERATOR

Provides properly modulated signals for checking VOR, localizer and glide slope receivers and instruments. Portable, it may be connected directly to receiver in the aircraft or outside by using a collapsible antenna.

RANGE: 108-136 mc: 280 channels and 329.3-335.0 mc: 20 channels
STABILITY: RF ±0.0065%; AF: 30, 90 & 150 cps ±1%; 9960 cps ±2%; 1000 cps ±15%. VOR accuracy ±0.05°.
PHYSICAL: 19" w, 18" h, 10½" d. Wt. 45 lbs.



479V-2 PRECISION OMNI-BEARING SELECTOR

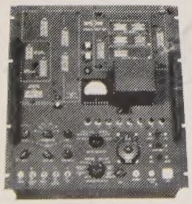
By using the 479V-2, navigation receivers can be tested and adjusted without introducing omni-bearing selector errors. This unit simulates a design center OBS as specified by RTCA. Inexpensive, the 479V-2 costs less than a standard A/C-OBS. For test panel mounting; the selector has 30° steps selectable by a tap switch.

ACCURACY: ±0.05° azimuth
DIMENSIONS: 3½" h, 19" w, 4" d.

479X-2

The 479X-2 resolver test set is designed to supply precision indexing facilities for calibration of omni-bearing indicators and OBS's. By means of a precision netowrk, resolver instruments of varying characteristics can be indexed within ±0.1° and will give uniform results in Collins 51R-2 and 51R-3 navigation receivers. Only two operational adjustments are necessary for resolver indexing — amplitude control and input level control. A 3-position selector switch and phase level adjustments located on the panel allow rapid calibration, when required.

ACCURACY: ±0.1°
DIMENSIONS: 3½" h, 19" w, 4" d.



478H-1 TEST SET

The 478H-1 and associated 413F-1 Power Supply provide complete self-contained testing facilities for the subassemblies of the 618S Transceiver. It also provides a convenient test station for detailed circuit checks. Lower portion of the test set panel carries all operating controls required to simulate functions of the 618S. The 413F-1 Power Supply provides all necessary operating voltages for the 478H-1.

DIMENSIONS: 21" x 17½" x 11"
POWER SOURCE: 115 v a-c, 50/60 cps @ 6 amps.

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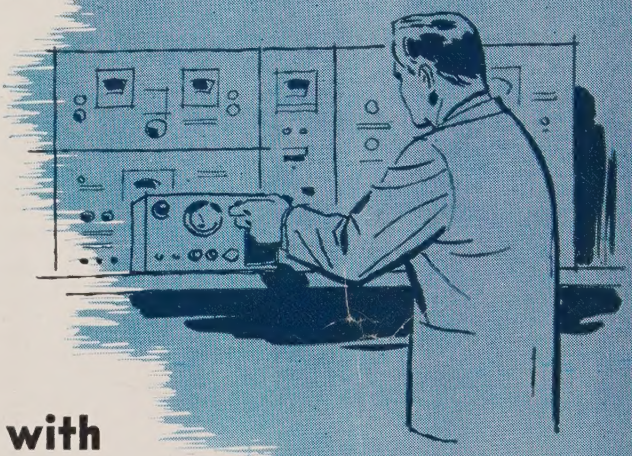

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UNIFORMITY — better equipment utilization by maintaining truly interchangeable navigation and communication equipment.

Other units not shown include 479U-1; compact, inexpensive VOR ramp test unit; 478C-1 A/C heading signal simulator, and the 180M-1 antenna tuning unit test set.

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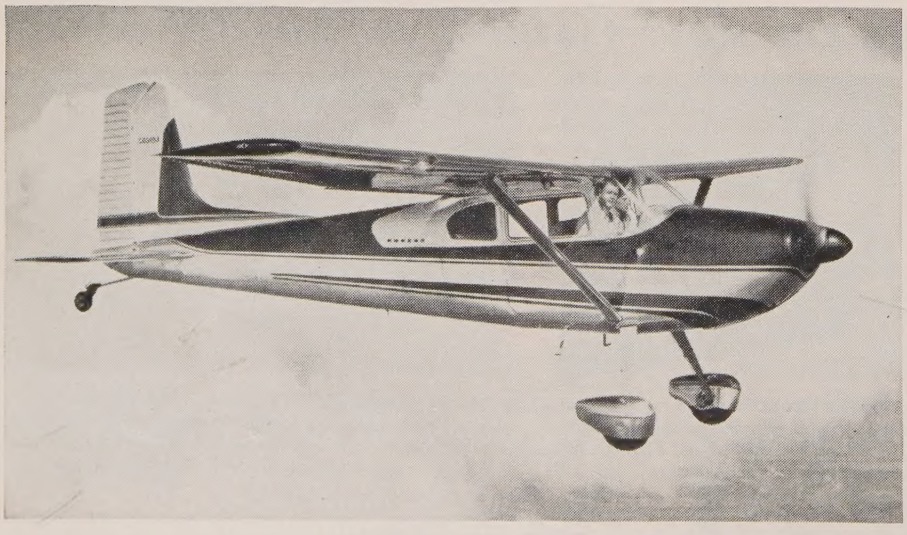

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PERSONNEL

Howard S. Cullman, Chairman of The Port of New York Authority for the past 10 years, has been named Honorary Chairman. **Donald V. Lowe** has been elected to succeed Mr. Cullman as Chairman of the Port Authority. **Bayard F. Pope** was elected Vice Chairman.

Donald B. Doolittle, Malcom McAlpin and **Vincent A. Theisen** have been elected to the board of directors of All American Engineering Company.

G. Lawton Johnson was elected to the board of directors of Greer Hydraulics, Inc.

Edwin A. Speakman was elected a vice president of Fairchild Engine and Airplane Corporation. He has been general manager of Fairchild's Guided Missiles Div.

Ted F. Walkowicz was elected to the board of directors of Piasecki Helicopter Corporation.

William B. Bergen has been elected executive vice president of the Martin Company.

Norman H. Golden was appointed chief engineer of Riddle Airlines. **Thomas N. Mathers** was named a director.

Frank W. Fink has joined Ryan Aeronautical Co. as vice president and chief engineer.

Col. Thomas L. McKnight has been named vice president of Hall Scott Motors Company.

John R. Alison, former administrative vice president of Northrop Aircraft, was named vice president in charge of customer relations. **Robert R. Miller** replaced Mr. Alison as administrative vice president, and **Gil Nettleton** has become assistant to the president of Northrop.

Harry A. Sosnoski has been named aviation advisor to the president of Olin Mathieson Chemical Corporation.

Vernon E. Hupp, Jr. was appointed assistant service manager of United Aircraft Service Corporation for Hamilton Standard products.

Major Gloria W. Heath, executive assistant to the director of Flight Safety Foundation, has been appointed Flying Safety Officer for the northeast region of the Civil Air Patrol.

Carl J. Eaton was named director of engineering, and **L. R. Lentz** was named assistant director of engineering of Champion Spark Plug Co.

Stuart E. Weaver has been elected vice president-engineering for the Radioplane Company, a subsidiary of Northrop.

Walter G. Bain recently was elected to the board of directors of Republic Aviation Corporation, and **Ken Ellington** was elected a vice president. **Richard G. Bowman** was appointed assistant chief engineer—production, **Dr. William J. O'Donnell,** assistant chief engineer—development and experimental, and **Robert L. Bortner,** assistant chief engineer—administration of Republic. **Russell (Rusty) Roth** was named chief experimental test pilot.

(Continued on page 4)

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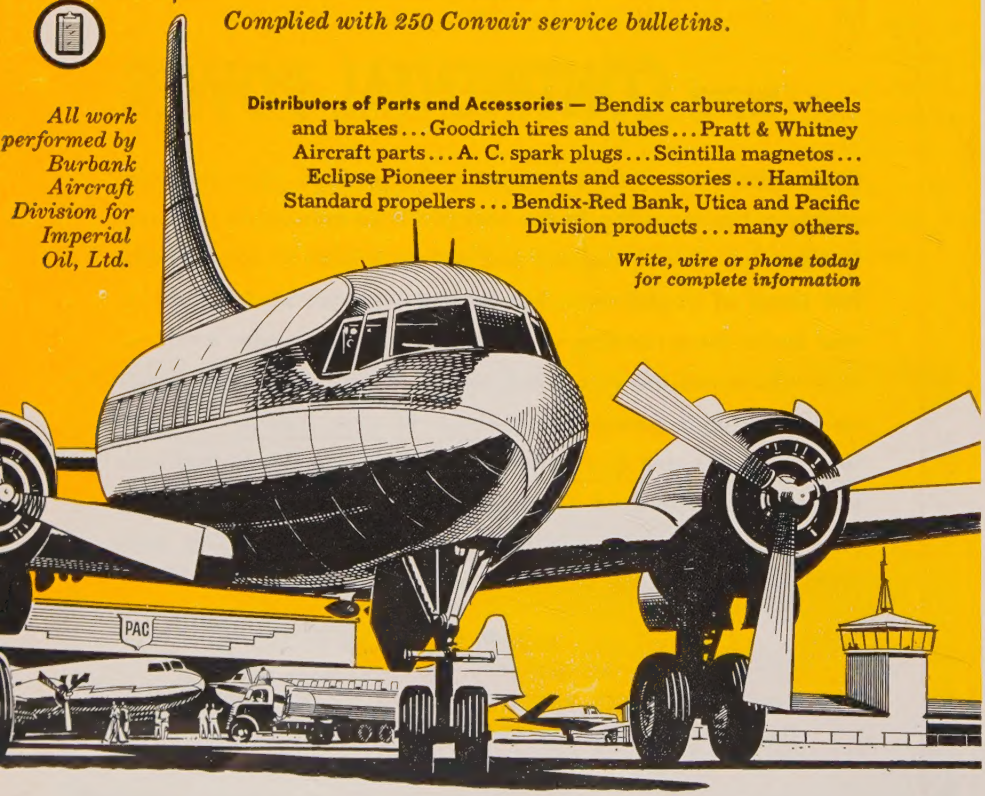

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Mark R. Miller has joined Servel, Inc., as chief of Defense Division.

George S. Lapham, Jr. has joined the legal staff of the Air Transport Association.

Edwin L. Thomas was appointed director of engineering for L.B. Smith Aircraft Corporation.

Ralph L. Bayless has been appointed chief engineer of Convair. **Jack L. Bowers, Jack Mason** and **Dr. Marvin Stern** have been named engineers of Convair.

Homer H. Evans, Jr. has been appointed advertising director of General Dynamics Corp., and **Kenneth Koyen** has been appointed Washington public relations representative.

James L. Jones was appointed an attorney for the Bureau of Air Operations, Routes and Carrier Relations Division of the Civil Aeronautics Board.

Ludwig T. Stoyke was named manager of the Hydraulics Engineering Dept., of Lear-Romec Division of Lear, Inc. **T. K. Greenlee** was named Division Engineering manager of the Grand Rapids Division of Lear, Inc.

F. Glen Nesbitt has been named sales supervisor of flight and engine instruments for the Aeronautical Equipment Division of Sperry Gyroscope Co. **Vincent F. Acri** has been placed in charge of sales of flight control systems.

James E. Bevins is assistant director of engineering of the Eclipse-Pioneer Division of Bendix Aviation. **C. D. Flanigen** succeeds Mr. Bevins as chief engineer of Bendix Corporation's Utica (N.Y.) Division.

James E. Mays has joined Southwest Airmotive, Dallas, as assistant manager of Southwest's jet engine overhaul operations.

Herbert (Zeke) Hopkins has joined North American Aviation as an engineering test pilot.

A. W. (Tony) LaVier has been named director of flying operations for Lockheed Aircraft's California Division. **Herman R. (Fish) Salmon** succeeds Tony LaVier as chief engineering test pilot. **Lewis H. Height** has been named chief project engineer for the Georgia Division of Lockheed.

John C. Holley was appointed vice president and director of sales of the Holley Carburetor Co. **Arleigh J. Hess** was named manager of aircraft activities.

Lee R. Urquhart has been named superintendent of purchasing and stores for Dallas Aero Service.

Robert E. Sawyer has been named chief engineer for Braniff International Airways.

James N. Krebs recently was named manager of the Development Engine Section of General Electric's Aircraft Gas Turbine Division. **Robert A. Averitt** was named manager of Aviation Systems Engineering for G.E.'s Aviation and Defense Industries Sales Department.

N. D. (Doug) Meadowcroft was appointed eastern sales and service manager for Hardman Tool & Engineering Co.

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JULY, 1955

Skyways

The Magazine of Flight Operations

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industry notes . . .

■ United Air Lines is testing a high-intensity lighting system which makes aircraft more visible both day and night. The installation on a DC-6 air coach consists of seven photographic strobe lights. Three are mounted under the fuselage and four on top, with two on either side of the dorsal fin. The lights are flashed in pairs (one below and one above) at the rate of 60 times a minute, moving forward from the tail. According to United's director of safety, Capt. Carl M. Christenson, the lights not only add to the 6's conspicuity but also clearly indicate its general direction of flight. This system was developed by Andrew Madsen, former UAL first officer who is now flying for Trans-Ocean Air Lines.

■ The Allison J71 turbojet engine has officially qualified as a 10,000-pound thrust unit. This qualification is based on the official 150-hour USAF test, during which the J71 demonstrated thrust in excess of 10,000 pounds with the highest pressure ratio of any single-compressor engine yet developed. This engine presently powers the Douglas RB-66, the B-66 and the Navy's F3H.

■ Fourteen different models of pneumatic starters for gas-turbine engines are now being built by Hamilton Standard Division of United Aircraft Corp., for six major engines and 16 types of aircraft. The starters have been in production at Hamilton Standard for the past four years and over 2,000 have been delivered. Ranging in horsepower output from 40 to 150 and weighing from 20 to 30 pounds, the pneumatic starters can fire up today's most powerful jet engines in from five to 20 seconds.

■ Two new liquid-propellent rocket motors have been announced in Great Britain. One, the Armstrong-Siddeley *Screamer* boasts a performance beyond Mach 2 and a combat ceiling above that of any of today's bombers. This new engine, designed for use in piloted aircraft, is reported also to offer a "fantastic rate of climb." The second rocket motor is the de Havilland *Spectre*, designed for high-performance interceptor-fighters. Flight trials with the *Spectre* are scheduled for this summer. Other details are classified.

■ Taylorcraft's new Fiberglas airplane recently successfully completed its CAA certification tests. Production models are now on the assembly line and deliveries are expected to begin immediately. The plane carries four passengers and is powered by a 225-hp Continental engine. It cruises at 150 mph and sells for $9,840.

■ The Allison 501 turboprop engine recently was issued the first certificate for commercial turboprop operation ever awarded by the CAA. Approval was based on the successful completion of a stringent 150-hour official USAF qualification test by the T56, military version of the commercial 501 turboprop engine.

■ Propellers of the KLM Royal Dutch Airlines *Super Constellations* are sporting a new and special treatment which is said to aid in cooling of the aircraft's engines and to add 5 mph to the speed of the planes. Experiments by KLM's propeller division disclosed that fillets of plastic cast on the trailing edges of the prop blades, flattening the round shape at the hub, provide the better engine cooling and additional speed. The prop blade is scoured clean, brought to the proper temperature by extremely hot lamps and then foam plastic is applied. It is then placed in an oven to harden, after which sheet rubber is fixed to the plastic and a final coat of paint applied as a protection against weather.

■ Link Aviation, Inc. has delivered a new simulator to Tyndall AFB, Florida. Developed in cooperation with Wright ADC and ARDC, the new simulator will be used to train pilots of the Convair F-102A interceptor.

■ Joclin Manufacturing Company, North Haven, Conn., has developed a new style collar for prop blades. In this case, the shank of a Hamilton Standard variable pitch prop blade is covered with a two-inch Fluorolin 404 tape and a film of chemically inert DuPont Teflon is bonded to aluminum foil and coated with a heat-resistant adhesive. The tape prevents erosion and offers a soap-like, free-sliding surface on which a rubber seal rides. It eliminates oil leakage and lengthens life of the seal. BOAC is the first airline to order in quantity.

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SPERRY FLIGHT RESEARCH *program investigating all-weather flight involved take-offs (above) as well as landings made under complete instrument conditions. In this case, ceiling was 50 to 60 feet and forward visibility, measured on the ground, was 365 feet*

All-Weather Flying

The hours of utilization of an aircraft, whether it be a business plane or an airline transport, is the measurement of the economic value of that transport's operation. Maintenance of airline schedules and successful completion of business flights is of prime importance in the utilization of aircraft, and weather often has been a deciding factor. One of the features of the Air Line Pilots Association's Third Annual Air Safety Forum recently was a panel discussion of All-Weather Flying. Because of its great pilot interest and because of its equal importance to business-aircraft operations and the airlines, SKYWAYS is herewith reprinting the text of that discussion, with the permission of ALPA—Ed.

All-Weather Flying: Operational Views

by David S. Little

Supt., Airways Aids & Electronics
American Airlines

"All Weather" is a very loose or broad term. Whether we may be able sometime in the future to completely disregard the existing weather situation remains to be seen. For all practical purposes, aeronautical engineering, manufacturing and operational experience already have eliminated or reduced to an inconsequential factor the in-flight icing problems which proved so costly in the past. The efficiency of the thermal airfoil, electric propeller and windshield de-icing methods employed on our latest air transports is so high that today few of us give much thought to the possible in-flight aspects of ice accumulation.

The other most accepted delay or hazard factor to flight, thunderstorms, appears to be meeting its end by the application and use of airborne and ground radar for the cicumnavigation of thunderstorms and turbulent heavy precipitation areas. So much knowledge already is available on the usefulness of radar that I believe we are safe in assuming the next five years will see thunderstorms go the way of in-flight icing.

To apply "All Weather" in a more general or accepted sense, let's assume we mean an operation so conducted that existing terminal weather will adversely affect safe operation only a small fraction of one percent of the total time involved. This appears achieveable in the foreseeable future, but at a price. Whether the cost can be justified has been argued.

In the case of one large air-transport operator who operates to legal basic minimums of only 300 and ¾, the records indicate these minimums permitted this carrier to complete 98.14% of all scheduled flights during 1954.

The percent of uncompleted flights obviously was small—only 1.86%. In looking at that 1.86% factor, this represents 584,495 miles cancelled for purely mechanical conditions. However, the miles cancelled for purely weather reasons represents 1,208,-020; slightly more than twice the miles lost for mechanical reasons. This amounted to $1,059,026 lost for mechanical and $2,341,761 lost for weather reasons. Dropping out the percentage of uncompleted flights at-

tributable to purely the mechanical, we find this carrier, using only a small part of the long-requested total terminal all-weather facilities and only the basic minimums of 300 and ¾, would have completed 99.39% of all flights scheduled in 1954. In other words, this carrier charged up only 0.61% of uncompleted schedules to weather. As some of the uncompleted flights were cancelled because of en-route thunderstorm conditions or lack of legal alternates within economic or fuel range, we must admit that, percentage-wise, the terminal all-weather considerations represent a rather small part of the total.

In general, these figures reflect the use of only one implemented runway during IFR weather, and all too frequently this one runway is not adequately implemented for all-weather flight. To the best of my knowledge we have only one runway in the U.S. implemented as requested by the Air Line Pilots Association for all-weather flight: Runway 4 at Newark (N.J.) Airport. Therefore, the mentioned operational reliability has been achieved with less than the desired aids and with single runways.

ALPA previously indicated that for maximum weather operation the following is desired:

1) Two long hard-surfaced runways oriented approximately 90° to each other and aligned so far as practicable to provide landing areas, useful under the specific field low-visibility *vs.* wind-velocity situation, with minimum tail or crosswind components.
2) Two ILS, each complete with LMM-LOM components on both front and back courses.
3) Four Configuration A approach-light systems, each complete with condensor discharge lights.
4) Both runways high-intensity lighted and with surface-painted markings.

While few major terminals have such a favorable location as to permit instrument approaches on a 50 to 1 clear-path basis to four runways (. . . and new airport cost is astronomical), let's assume the airport already provides the two runways and we need only the electronic and lighting implementation. Let's further assume that the airport already has one complete ILS, GCA and Configuration A approach lights. While costs vary widely, what we are actually talking about is an expenditure in the order of $385,000 per terminal.

Recalling the small percentage of incompleted scheduled flights due to weather (0.61%), is such a percentage worth such cost? Personally, I think so. While it may be economically unjustified today, it will be so tomorrow.

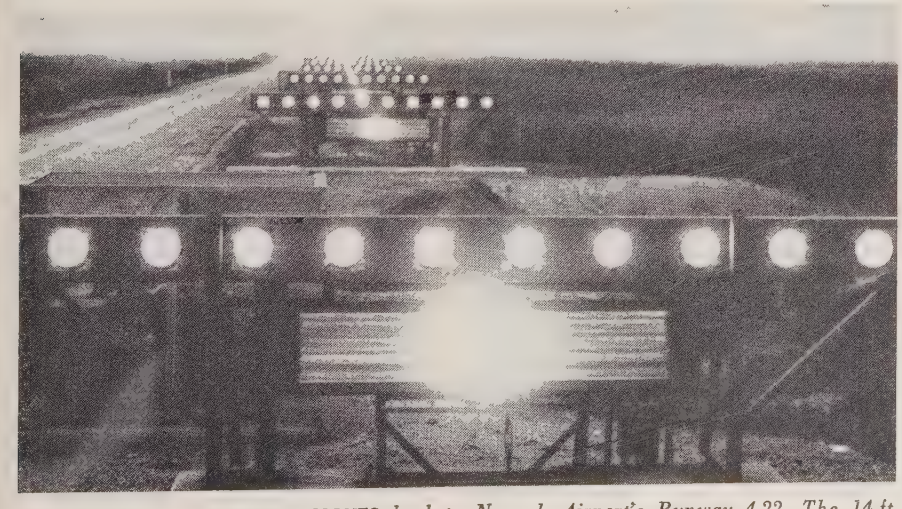
The mentioned percentage of completed schedules figures, as normally accounted for by most air carriers, do not reflect the percentage of schedules completed *on time*. Many of the reported completed schedules were completed very late; frequently so because of having to wait for terminal weather improvement, while others are completed but at alternate airports.

As we all know, the capital cost per aircraft unit has a very significant effect on how closely management watches its aircraft utilization figures. Most of us can recall when management thought little of our requesting a DC-2 or DC-3 for pilot training, for looking over a new route, or at some new accessory equipment development, or for route qualification establishment. Today it is difficult to find a DC-6, a -7 or a 1049 for just the legally required pilot proficiency checks. If a manufacturer of a new gadget doesn't show up with his own aircraft to demonstrate his new product, it usually doesn't get looked at, and route qualification we do on schedule or else. Aircraft utilization costs are high and economically important today.

In this matter of aircraft utilization, I have felt that manufacturers of automatic pilot equipment have missed the boat, sales-wise, by trying to sell their products on the basis that with automatic approach couplers it could make a better ILS than a pilot could. I was, therefore, pleased recently to see one such manufacturer and an airline make a study to see how much straighter the autopilot could wheel than would a pilot, and how much better the autopilot could keep the plane on the step at maximum speed than would the average pilot. While this survey was too meagre to bring out all the facts, these two outfits did come out with this statement: "The annual savings in dollars, using direct operating costs only, is $250,000 by using automatic pilot on a fleet of 25 DC-7's."

This survey concerned only the en-route level of flight savings. Details show this money is salvageable by saving only 6.20 minutes of time in an 8-hour, 30-minute non-stop flight; percentage-wise, only 1.25% of the flight time. Seconds saved in the operation of modern transports rapidly builds up to a staggering number of dollars.

The economics of current air-carrier competition have made the scheduling of aircraft maintenance a large factor in the total operations cost. Large carriers find it economical to schedule and route their aircraft so that one legally required maintenance check is accomplished



HIGH-INTENSITY APPROACH LIGHTS *lead to Newark Airport's Runway 4-22. The 14-ft. wide top bars burn continuously; bottom bar is flashing lead-in light to center of runway*

RUNWAY *4-22 is Newark Airport's instrument runway. Photo made over the MM*

here, the next one at some other terminal on their system, a third at possibly another terminal, and the major progressive overhaul check at still another. This scheduling and routing of fleet aircraft so that each winds up where desired within the legal time limits and with no unused legal time to spare represents millions of dollars to the air-carrier industry. These dollars could be applied to the net profit side of the ledger.

The all-weather implementation of terminals and aircraft is directly related to these economics of aircraft utilization. An aircraft losing a minute here, five minutes there, from the effects of terminal weather on a single operation quickly throws aircraft maintenance scheduling into a cocked hat and at an uncalculated cost.

While actual cost figures are difficult to accumulate, it is my humble opinion that safe, reliable, on-time scheduled operations (on-time because of terminal all-weather flight facilities) would go a long way toward payment of the terminal costs.

The need for certain electronic and visual-aids implementation of the terminal does not cover the total gamut of needs to make all-weather flight safe and economical. Consider these factors:

1) The need for sufficient, effective, high-speed runway turnoffs.
2) The need for terminal gate space to effectively utilize the maximum capacity of all-weather runways. Remember, those runways are costly and we can't get two if one would suffice.
3) The need for greatly improved means of guiding the aircraft at reasonable taxi speeds from the runway to the gate and vice versa in visibilities so low that ground traffic normally finds it hazardous to move.
4) The need for clean, smooth, dry runways or perhaps we should term it optimum coefficients of runway friction. Reverse props or reverse jet thrust does not provide Joe, the pilot, much tranquility of spirit when runways are ice covered or wet. Joe's "twitch factor" is directly related to available runway friction.
5) The need for greatly improved windshield cleaning, particularly in moderate-to-heavy rain conditions. Late military jet fighters have very effective windshield cleaning by bleeding hot compressed air across the outside of the windshield.
6) The need for aircraft flight instrumentation which will permit the Captain of a $4 to $5 million jet transport to become master instead of wheelsman of his expensive craft. An autopilot-approach instrument cannot do any better on an ILS than the average airline pilot; in fact, it can't do as well. The pilot knows the bumps and bends in localizer and glide slope, disregards them and provides the customers a smoother ride. But this equippage does provide the pilot that always-essential "time to think," to be master instead of the wheelsman.

All-weather flight is possible and can be accomplished safely and economically, given a little encouragement and development time.

All-Weather Flying Requirements

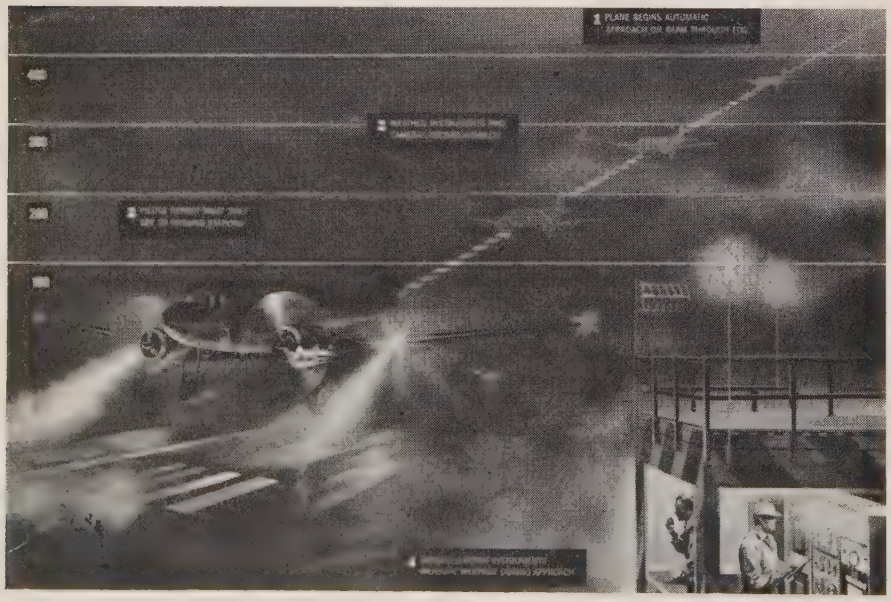
by Capt. E. A. Cutrell

American Airlines

Every pilot knows that the aids and facilities for weather flying are inadequate for present operating practices and landing minima. Such inadequacy is confirmed by looking at the causes of weather accidents during the past year. Many of these accidents have resulted from the failure to provide the necessary and required aids that have been developed, perfected and are available.

For example, consider the approach and landing accident of the Italian airliner at New York International Airport (Idlewild). Contributing factors to this accident may have been: 1) insufficient radio and visual approach aids for two-direction landing, and 2) installation of obsolete slope-line approach lights at Idlewild. Some meteorologists estimated the wind at the time of his approach to Runway 4 to be 180° at 40 knots at 1,000 feet. Certainly one of the world's leading airports, Idlewild, should be equipped with a minimum of two complete ILS and approach light systems to preclude ever making a downwind instrument approach and landing. The slope-line approach lights may have been mistaken by the pilot for runways lights. It is highly important that the center-line high-intensity approach light system (standard Configuration A) with adequate threshold and runways lights (*See SKYWAYS, March and*

(*Continued on Pg.* 38)



NEW WEATHER MEASURING SYSTEM *tells pilots when they will first see vital ground references from cockpit during bad-weather landings. System developed by Sperry*

ZERO READER *flight director tightly couples the aircraft to the ILS*

Champion Helps Write Another Bright Record In Air History:

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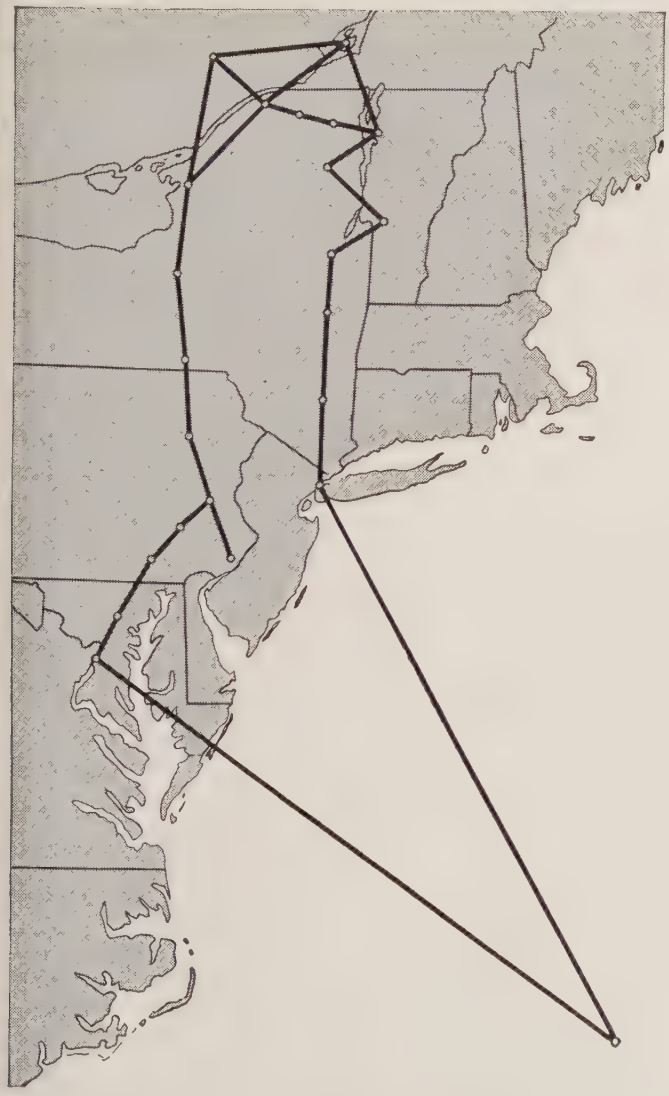

- *Twenty-five consecutive years without serious accident*
- *Fifty million miles flown between U. S., Canada and Bermuda*
- *One billion safe passenger miles*

Colonial Airlines' continuing record of more than a quarter of a century of operation without a serious accident is a great tribute to its safety-minded management and personnel and to the equipment they fly. Champion is proud of its part in helping Colonial achieve and maintain this record.

The vast majority of the world's scheduled airlines rely on Champion Spark Plugs for top performance, complete dependability and real operating economy.

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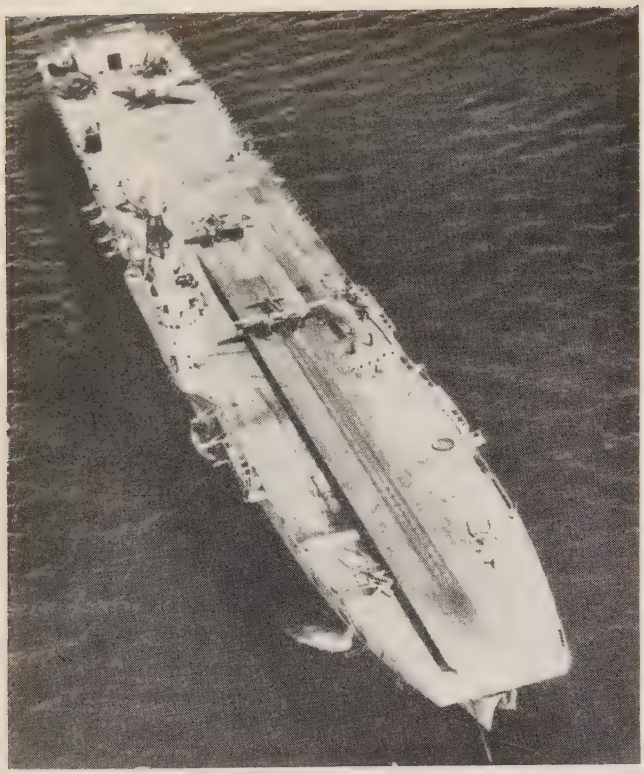


Steam Catapult for Aircraft Carriers

by D. A. Smith

HMS PERSEUS *was "test-bed" for British—developed steam catapult. Tracks on operational version are flush with carrier deck.*

Research and development into flight deck techniques is paying its full dividend on *HMS Ark Royal,* Britain's new and most formidable aircraft carrier. Her deck is angled, she has improved arrester gear, port and starboard mirror sights—and two steam catapults, the first to be installed operationally.

These catapults, details of which can now be revealed, are capable of launching the largest and fastest aircraft envisaged for naval use. They are to a design which has been accepted not only by Britain's Admiralty but also by the United States, French, and Dutch naval authorities. Brown Brothers and Company Ltd., of Scotland, the firm which developed the steam catapult for the Admiralty, are currently working on installations for ships of the Canadian and Australian navies. Ultimately steam catapults will replace the existing hydro-pneumatic catapults in all the other operational carriers of the Commonwealth navies.

The development of the steam catapult is another example of the length of time necessary to bring an advance in naval machinery from the drawing board to the production stage. It was given trials on the *HMS Perseus* in 1950, and those trials continued into 1951. The *Perseus* went to Philadelphia, Pa., where the new device in its experimental form was demonstrated successfully to the U.S. Navy and received almost instantaneous approval. As long ago as 1936 Mr. C. C. Mitchell, now a director of Brown Brothers but then employed by another engineering firm, was working on patents for a steam catapult in which the principle of the slotted cylinder was to be employed.

With an ordinary steam engine the piston, which is moved by steam pressure within the cylinder, transmits its power by means of a connecting rod which protrudes through one end of the cylinder. In the slotted cylinder, the piston has no such rod protruding through the end of the cylinder. The power is transmitted by an arm attached to the piston and protruding through the slot in the side of the cylinder. Such a cylinder can be of almost unlimited length. Of course, some means had to be devised for preventing the steam from escaping through the slot. Therein lay the challenge to the engineer.

Mitchell's pre-war patents were considered by British naval authorities to be worthy of trial but there was, at the time, no money available for the building of a trial set. Moreover, the alternative methods of powering a catapult were proving adequate for the comparatively light aircraft of that day. Catapults were, of course, used ashore by the Wright brothers. The naval version was developed from the compressed-air-operated device, such as fitted into *HMS Vindictive* in 1925, through a cordite-operated catapult to the hydro-pneumatic types still in use.

Mitchell was serving as a Commander in the Department of the Engineer-in-Chief of the Fleet during World War II, and it was then becoming apparent that the hydro-pneumatic type was reaching the peak of its development. It incorporates a complicated series of wires and pulleys. As naval aircraft increase in size and speed of launch, so this gear needs to be larger and heavier. For the aircraft now envisaged it would be altogether too big and heavy to introduce into a ship of normal size. With the slotted cylinder, only the piston and the arm and shuttle attached to it move. Hence, it does not have the limitations of the older type.

Mitchell's initial approach to the problem was interesting in that it took the form of literary research. As an engineer, the principle of the slotted cylinder was familiar to him, and he patiently went into all the material in libraries and the specifications of the Patent Office in London which related to the applications of this principle.

Mitchell found that in 1810 George Medhurst, an engineer from Kent, England, proposed the propulsion of trains within a tube by air pressure. He conceived the idea of forming a tube with continual communication between the inside and the outside without allowing the impelling air to escape, and by this means causing a railroad car to run along the permanent way. A few years later he published a pamphlet entitled "A New Way of Inland Conveyance of Goods and Passengers at 60 mph without the Aid of Horses or any Animal Power."

The difficulty of preventing the air from passing through the slot in the cylinder was considered by Samuel

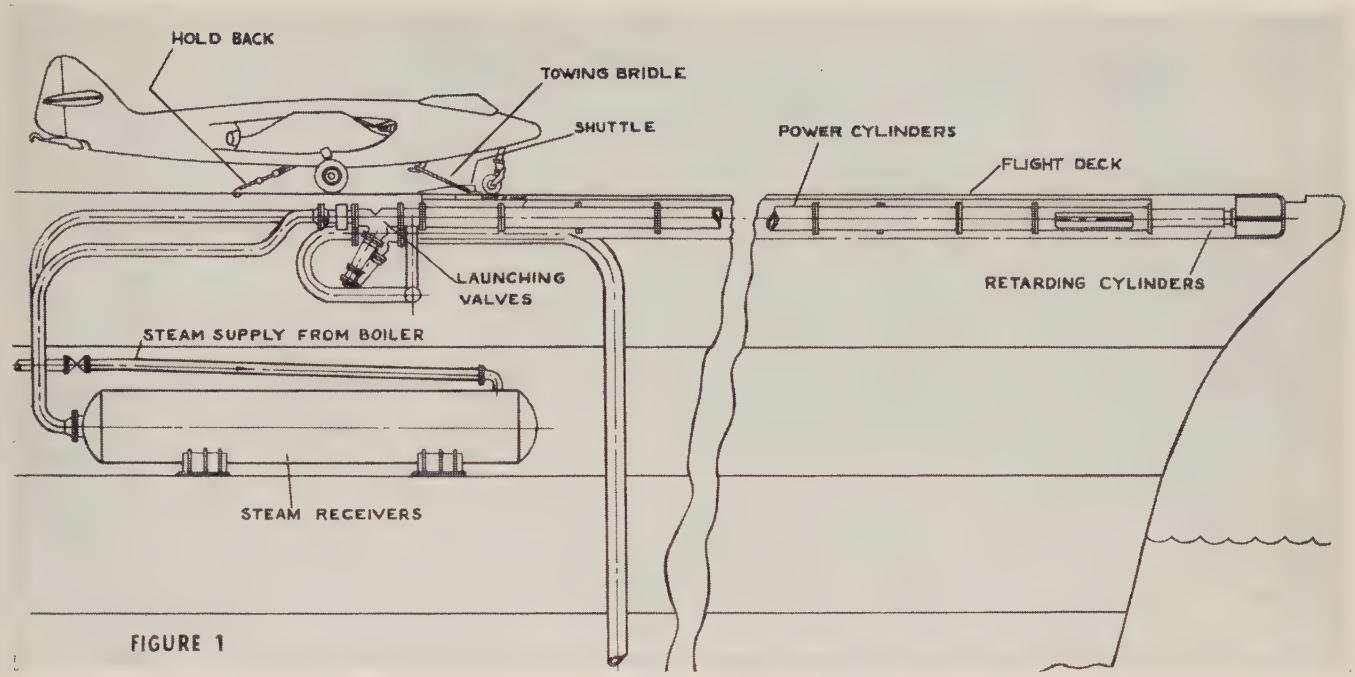


FIGURE 1

Clegg who, in 1839, patented a form of valve for doing this job. Joining forces with one Joseph Samuda, he published a treatise on the "Atmospheric Railway." Lying on the sleepers, a continuous cast-iron tube would have his patent valve to seal the "slit" all the way along it. The arm from an attachment to the rear of the piston in the tube came up through the "slit" and was attached to a railroad car. The valve covering the "slit" was in the form of a continuous belt hinged to the tube. In this system, pumps were to exhaust air from the tube and so suck the train along.

An experimental line actually was laid on part of the West London Railroad near Wormwood Scrubs in 1840, and it was sufficiently successful to be imitated on a branch line of the Dublin-Kingston Railway, which worked from 1843 to 1855. It is said that the loaded train reached a speed of 45 mph; if the brakes were not applied in time before the piston got out of the tube, "the whole train ran through the station and right out of the gates."

That great engineer and innovator, I. K. Brunel of Great Eastern fame, was so impressed by the system that he prevailed upon the Select Committee of the South Devon Railway Directorate to adopt the atmospheric system on a West of England line in 1847. While it worked well at first, rats and salt water, where the permanent way ran by the sea, damaged the leather used as part of the sealing device. The South Devon company was

(*Continued on page* 27)

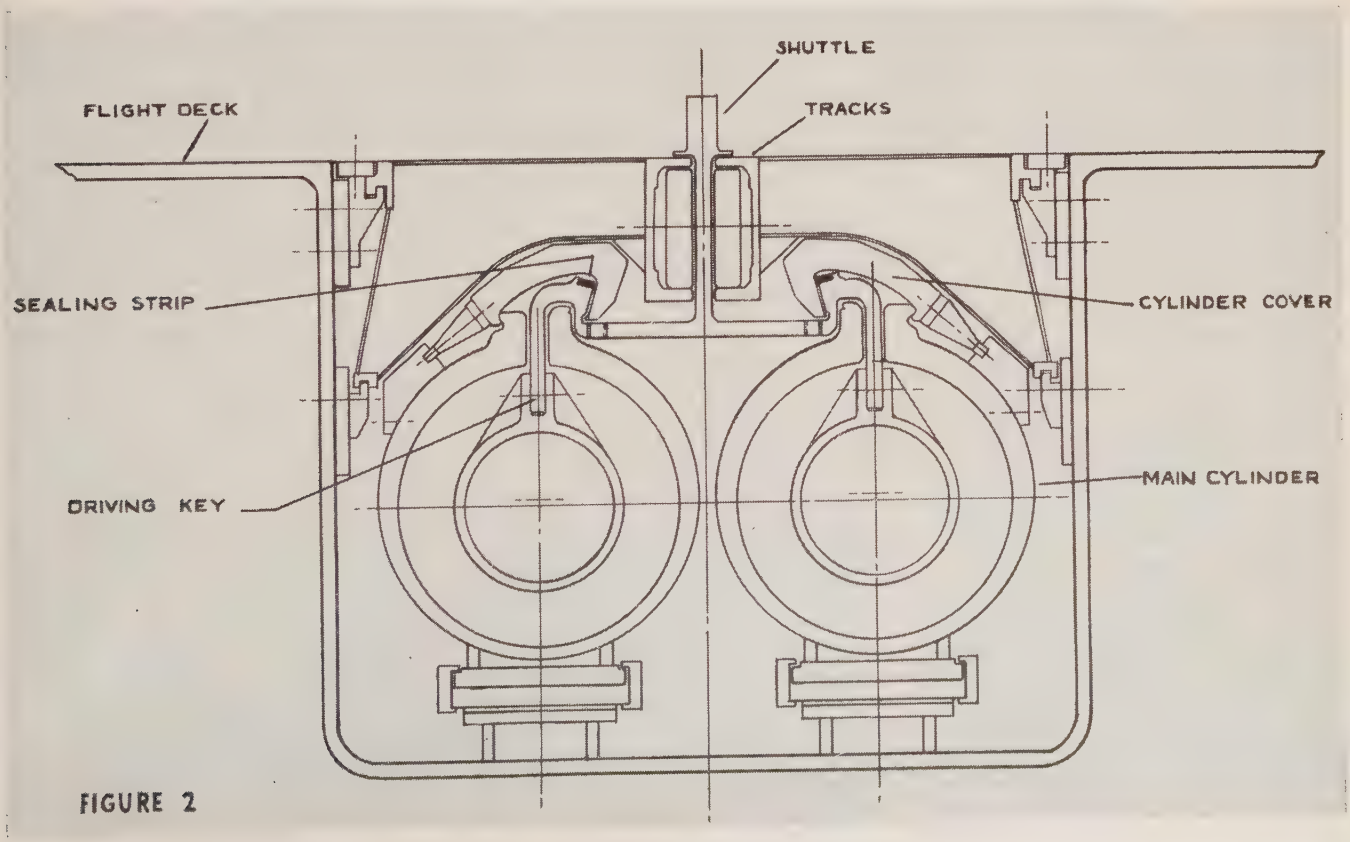
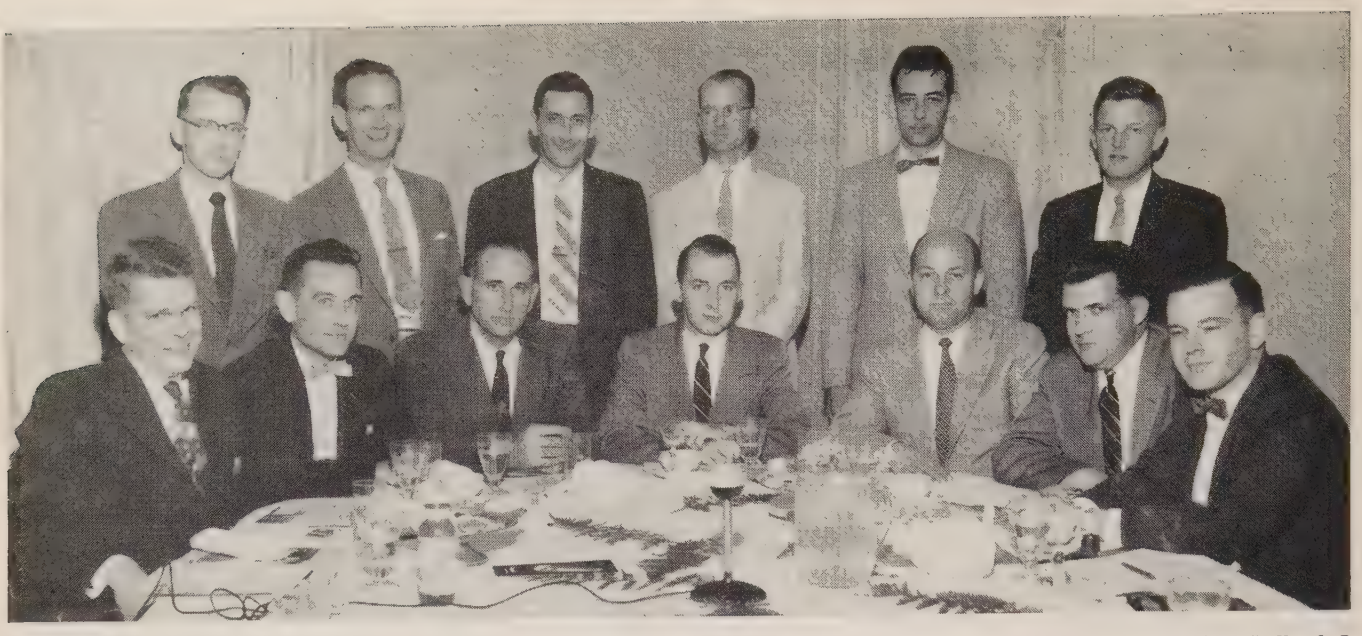


FIGURE 2



PROBLEMS *involved in the installation of airborne radar were discussed at the Round Table attended by (left to right, standing) Don Ladd, Page Airways; George Church, Bendix Radio; Gene Baker, Bendix Radio; Robert Terry, Airtron, Inc.; E. D. Kelley, Reading Aviation Service; Donald Grempler, Bendix Radio; and (left to right, sitting) Calvin White, Airmar Radio; Rolland S. Mangel, RCA; George McCauley, Airborne Electronics; Vincent Fenton, Lockheed Aircraft Service; W. F. Palmer, RCA; D. W. Juston, Page Airways; and B. R. Rashkow, Flight Safety, Inc., who served as Moderator of the discussion held at the Wings Club.*

SKYWAYS FLIGHT OPERATIONS ROUND TABLE

Problems Associated with Installation of Airborne Radar

Moderator B. R. Rashkow (*Dir., Electronics Engineering, Flight Safety, Inc.*):

"Recent airborne radar evaluations by the military and the civil air carriers have stimulated considerable interest in this subject among both airline and corporate-aircraft operators. In recent years, radar and its attendant advantages probably has attracted more attention in the commercial aviation field than any other development, short of the commercial jet transport itself.

"In the business-aircraft field, several conversion centers already have modified corporate DC-3's and *Lodestars* for radar installations, and we are fortunate today in having representatives of several of these companies with us. We hope to be able to draw on their experience by having them describe some of the problems they encountered during the installation of these equipments, and their solutions. We know, for example, there is a problem involved in the relatively high AC power requirement. The location of the PPI indicator presents a problem in some instances, as does antenna mounting, stabilization, etc.

"To begin our discussion today, I'd like to call on Don Ladd of Page Airways, Rochester. His company recently completed the installation of a Bendix RDR-1 airborne weather radar in a corporate Lodestar.

"Mr. Ladd, did the nose of the Lodestar *require extension to accommodate the radar antenna, and what was Page's general approach to both the radar and the waveguide installation problems?"*

Donald Ladd (*Electronics Supervisor, Page Airways, Inc.*): "Probably the biggest structural modification necessary on the airplane was to the nose. We did not extend any of the basic structures of the nose section, but we did considerable rework in order to meet CAA approval and provide a suitable mount for the RDR-1 antenna. We cut the nose section at the first station and attached a solid panel on which we mounted the radar antenna. The Fibreglas radome slipped neatly over the whole assembly and was attached to the solid panel, presenting a good appearance.

"One of our biggest problems is relocation of radio equipment if that equipment is so far forward as to interfere with the installation of the antenna and the radome. In some airplanes the solution to that is time-consuming and costly. On the Forrest Oil *Lodestar* most of the radio rack was

rebuilt to utilize available space after the nose modification.

"Weight consideration also is an item of importance. In the Lockheed installation, the total weight of the equipment on the nose was roughly 67 pounds; that included the antenna, casting, radome and beefing material. Preferred location for the units is near the antenna. The further the unit is from the antenna, the higher the cost of the installation. The waveguide installation in itself is a time-consuming proposition and sometimes is a difficult job because it has to be handled carefully and mounted in such a position as to permit easy removal or service, and easy disconnection in case you wish to dismount the antenna. In short, the waveguide has to be installed so that the entire system can be easily maintained."

D. W. Juston (*Sales Mgr., Page Airways, Inc.*): "Bert, we did not build the radome. It was furnished us by a supplier, and during the course of the installation, we discovered several things about the radome that needed improvement. For example, there is quite a close tolerance on the side of the radome where the antenna rotates. Actually, after the first installation we were able to furnish the supplier of the radomes with enough information to enable him to fabricate a higher quality and better fitting one."

Bert Rashkow: *"Could you mention some specific items that needed improvement?"*

D. W. Juston: "The mounting plate that we built to accept the radome itself could have had another half-inch clearance. Also, the clearance on the sides of the radome where the antenna rotates could have been increased another half inch. In addition to that, the aluminum strip that is attached to the rear of the radome and is feathered into the airplane skin could have been 4 inches longer.

"These things are now worked out and the radomes we have on order will incorporate these improvements."

Bert Rashkow: *"What sort of sealing did you use where the radome meets the fuselage?"*

D. W. Juston: "Zinc chromate seam sealing compound."

Bert Rashkow: *"What paint did you use on the radome?"*

D. W. Juston: "A neoprene base paint and a matching color paint that was laboratory-tested for absence of lead or other metal qualities. This is very important."

Calvin W. White (*Pres., Airmar Radio Service, Inc.*): "In the bulkhead that the antenna is hung on, what size opening do you have in back of the antenna mounting?"

ROUND TABLE PARTICIPANTS

B. R. RASHKOW, Moderator of the discussion, is an electrical engineer and former Communications Engineering Supt. with Pan American World Airways.

D. W. JUSTON was an Air Force pilot for six years before he joined aircraft electronics sales and service field with Page Airways in '46; he is Sales Manager.

W. F. PALMER, liaison engineer for RCA, has spent 15 years in the electronics field. He is presently doing radar liaison engineering with the airlines.

DONALD LADD, electronics supervisor, spent 11 years with Colonial Airlines at LaGuardia Field, N. Y., before joining Page Airways at Rochester, N. Y.

ROLLAND S. MANGEL has been a Marine Corps pilot since 1941; he joined RCA in 1946; was recalled to active duty in Korea, then rejoined RCA in 1953.

GENE BAKER was a Research and Development officer and pilot for USAF before he joined Bendix Radio in 1951. He is Supervisor, Executive Aviation Sales.

VINCENT P. FENTON joined Lockheed Aircraft Service in 1952 after spending two years in All Weather Test Section, Naval Air Test Center at Patuxent River, Md.

GEORGE W. CHURCH, Chief Engineer, designed the Bendix RDR-1 weather radar and CAA's ASR-3 airport surveillance radar; has been designing radar for 10 years.

CALVIN W. WHITE was foreman of American Export Airlines' radio shop from '43 to '47; has been president of Airmar Radio since he left American Export in '47.

ROBERT W. TERRY is a graduate of MIT; has been production test engineer for GCA and military radar systems, and an applications engineer, microwave systems.

DONALD E. GREMPLER has been in Aviation Flight Test Section of Bendix Radio for the past year and a half; was AF pilot during war, then an airline pilot.

E. DESMOND KELLEY, director of customer maintenance, joined Reading Aviation Service in 1946; has been electronic and electrical shop foreman, manager.

GEORGE W. McCAULEY, president and general manager of Airborne Electronics, Inc., is the Eastern Distributor for RCA's AVQ-10 airborne weather radar system.

Don Ladd: "We made a hole that's about 5 inches in diameter, just large enough to enable you to reach in with your hand and disconnect the main plug. A coverplate provides a seal between the nose section and the radar interior."

Cal White: "Does your waveguide attach to a bulkhead fitting?"

Don Ladd: "The waveguide fits onto the bulkhead by a bracket at the flange. It is not actually a bulkhead fitting."

Vincent P. Fenton (*Electronics Engineer, Lockheed Aircraft Service—International*): "Did you notice any interference or modulation effect on the glide path system caused by the radar dish rotating near the glide path antenna?"

Don Ladd: "As far as we determined, there was no interference. It was tested by both the pilot and ourselves, and we did not recognize any interference of any nature. Photographs of the installation may give the appearance that the glide slope antenna is very close to the dish, but it really is 3 or 4 inches below the dish."

Bert Rashkow: *"Douglas Aircraft Company has designed a DC-6 radome/glide slope antenna installation similar to Page Airways' where the glide slope antenna is placed close to the radar antenna. According to Douglas' experience, there was relatively no interference as far as glide slope signal reception was concerned.*

"Don, was there any reason for mounting the antenna so that it was suspended from above rather than supported from below?"

Don Ladd: "Design of the radome

"SEAM SEALER *used," reported D. W. Juston (sitting between Mr. Palmer and Mod. Bert Rashkow), "was a zinc chromate compound"*

"MOUNTING PLATE *should be aligned with the gyro," reported Mr. Church, left of R. Terry; right of Gene Baker and Don Grempler*

was the main reason. The radome has a slightly protruding area at the top which allows for clearance on the casting that supports the antenna itself. However, it could be mounted inverted."

Gene Baker (*Supervisor, Executive Aviation Sales, Bendix Radio*): "The radome was designed to minimize any change in the original contour of the *Lodestar* and in so doing a slight bump on top resulted in order to allow clearance for the antenna mounting base. Reversing the antenna and the slight radome bump would not allow as smooth a contour since the bottom slope of the *Lodestar* is much steeper than on top."

Bert Rashkow: "*Don, did you use a rigid waveguide . . . and if you didn't, what waveguide did you use?*"

Don Ladd: "We used the standard Airtron waveguide, some rigid and some flex. On a straight run we used rigid, and when it became necessary to make a bend, we went to flex. Of course, we used flex at the antenna and the transmitter-receiver ends."

Bert Rashkow: "*The* Lodestar, *of course, is similar to the* Learstar, *but in the* Learstar *you are faced with another significant problem. You can't have an inline pilot mast in a radar-equipped aircraft, so you have to relocate it. Have you given any thought to such a rework and to the problems it presents, possibly in certification, if you have to rework the airspeed system on the* Learstar?"

Don Ladd: "As far as I know, no *Learstars* have been modified as yet, and I haven't given it any particular thought. It would, of course, have to be CAA approved, but I can't see where it would present any particular problem other than getting the approval for relocation of the pilot."

D. W. Juston: "We're going to have that problem shortly inasmuch as the next *Lodestar* we have scheduled has the airspeed located in the nose. The modification was done about a year and a half ago, and installing the radome will mean returning the pilot to its original location."

Rolland S. Mangel (*Mgr., Commercial Aviation Sales, RCA*): "Roughly how far back do you think you would have to carry the fairing to obtain a smoother contour?"

D. W. Juston: "It's our opinion that another 4 inches is sufficient."

Rolland S. Mangel: "Would you say that it would make a better feathering job as far as feathering the fairing into the fuselage?"

D. W. Juston: "It would make a total of 8 inches of fairing and give the metal men a chance to smooth it out so they can seal it better than they can the shorter one."

Bert Rashkow: "*If you find that you have to increase the fairing by 4 inches, wouldn't you have to run some of that fairing up on the radome itself? And if you do that, you'd have to install space cloth under that portion of the radome that is covered by the metal fairing on the outside.*"

D. W. Juston: "We were speaking about an extension to the rear of the radome. The fairing that already is attached to the radome wouldn't be extended forward; it would be only to the rear."

Bert Rashkow: "*How many man-hours do you estimate it would require to remove the radome to gain access to the antenna for possible trouble-shooting? Would it be more feasible to gain entry to the radome by going into the radio rack and removing all the radio components?*"

Don Ladd: "It would depend on the particular installation. In the *Lodestar* if we did it would be necessary to go through the radio compartment to the nose. However, too much time wouldn't be involved . . . it's just a matter of removing radio units from the rack. A complete removal of this antenna, radome, panel assembly could be done in about 45 minutes."

Bert Rashkow: "*Are the racks removable so that a man can work a little more freely in that area?*"

Don Ladd: "The racks are not readily removable, but there is sufficient room between them to get in to take out the mounting bolts that secure the assembly to the airplane."

Bert Rashkow: "*Did I understand you to say that the entire radome, the bulkhead and antenna assembly are demountable from the Forrest Oil aircraft?*"

Don Ladd: "That's correct. The antenna power cable and waveguide can be removed from the airplane via mounting bolts that are accessible from the radio section of the nose. The whole assembly can be taken out and into the shop for servicing."

Bert Rashkow: "*I presume transmissivity tests were made on this radome?*"

Gene Baker: "Yes, complete tests were made on this radome and it was found to be excellent for the purposes intended."

George W. Church (*Chief Engineer, Commercial Aviation Dept., Bendix Radio*): "The radome is a single thickness; it is not a layer with honeycomb in between. Because the problem is not one of maximum transmissivity, it is not as good a radome as you might possibly be able to get—a honeycomb might be better—but it is completely adequate and the transmissivity runs high enough so there is no need for concern regarding operation. We feel there would be no advantage to improving it."

Bert Rashkow: "*Would the radome offer any ill effects at C-band frequencies since it was designed for optimum performance at X-band frequencies?*"

George Church: "Radomes of this design are better at lower frequencies. Therefore, the radome is better at C-band than it would be at X-band, but it is entirely adequate for both."

Bert Rashkow: "*Don, how many operating hours would you estimate the* Lodestar *has on it as far as this radar installation is concerned?*"

Don Ladd: "Probably well over a hundred."

Bert Rashkow: "*Have you noticed any signs of abrasion or a wearing of the radome nose?*"

Don Ladd: "After several hundred

hours of flight, you might find it advisable to touch up or repaint the radome, but the airplane we're talking about was in last week and it showed no damage to the radome after the hundred hours of flying."

D. W. Juston: "Incidentally, they have flown through several intense storm areas and through various frontal activity. The pilots maintain the RDR-1 radar is the best piece of equipment they have in the airplane. It has given them several turbulence-free rides and the increased comfort has been very apparent to the passengers."

Bert Rashkow: *"Going back to the radome painting, what if the corporate plane owner wants to continue the color scheme of his airplane right up to and including the nose? What if he doesn't want a black nose?"*

W. F. Palmer (*Liaison Engineer, RCA*): "In working with several military installations over the past couple of years, I have seen different colors of materials used to paint the radome and most of them have proved satisfactory. Lead pigments cannot be used, but those with neoprene or a similar base can be."

Bert Rashkow: *"But you can only get those paints in 50-gallon drums. That's a lot of paint for just one radome."*

W. F. Palmer: "I think packaging could be arranged to meet the needs of the corporate-plane market."

Bert Rashkow: *"Can you paint over the neoprene coating without having any adverse effects on radome performance, or could we get a colored neoprene paint?"*

Vincent P. Fenton: "If the radome must match the rest of the exterior paint trim, you would require colored neoprene. Paint applied over the neoprene would be worn away rapidly, revealing an irregular and unsightly pattern of neoprene. The radomes which we install for the Air Force have the frontal area of the radome, which is subject to corrosion, coated with neoprene in its natural color. Aft of this area, we use a thin coat of normal MIL-E-7729 gloss enamel. Also, we use two types of neoprene, Goodyear #23-565 or Gateco #N-79. The Goodyear compound is dark brown and rapidly darkens to black in the sun, while Gateco is a mustard brown and turns to dark brown."

Bert Rashkow: *"George, what about the thickness of the layer of paint?"*

George Church: "The design of this type of radome requires a thin wall. You must keep it to a thickness of about one-tenth of a wavelength and no greater. In fact, the thinner the better. The closer the dielectric constant is to 1, the better off you are. If you use a paint which has lead in it, obviously you are not going to see through it at all. A paint that is more like the material of the radome is good. The rubber-base paints seem to be perfectly suitable dielectrically, although no one has really found a good solution to the problem of wear.

"Incidentally, we are running some abrasion tests on a material called 'Hypolon.' It's similar to neoprene, and our erosion tests thus far indicate it offers better potentialities. From the standpoint of rain erosion, it looks as though it will compare with aluminum."

Vincent P. Fenton: "What about the problem of bird and hail resistance with a thin-wall radome? In proposals made to install de-icing boots, it has been pointed out, that the boots provide an extra resistance to bird and hail impact. Would boots be of special help on thin-wall type radomes?"

Rolland S. Mangel: "The danger is much less with a thin-wall dome than with a sandwich dome; a thin wall is stronger all the way through. Convair, by the way, will be using thin-wall domes on their Convair-liners."

Bert Rashkow: *"What tests were made to establish the mechanical satisfaction of the dome on the* Lodestar*?"*

Gene Baker: "Manufacturers of the Fibreglas and the resin went through tests as did the makers of the radome. In addition, a section of the dome was tested to get a measure of tensile and comprehensive strength. This test showed it was a great deal stronger than the Plexiglas nose previously approved for the *Lodestar*. While it isn't as strong as the metal nose, it does approach that strength."

Bert Rashkow: *"A serious problem in connection with a radome-equipped DC-3 is instrument removal. Installing the radome, we replace the whole front section of the DC-3 back as far as the first bulkhead. If you want to remove an instrument from the panel, you either have to have a four-foot arm or a completely removable instrument panel.*

"Mr. Mangel, what is AirResearch doing about that?"

Rolland S. Mangel: "Since their one installation to date was on a research airplane, it hasn't been a problem. However, it will be when we get into executive-aircraft installations."

Bert Rashkow: *"Apparently then, you would have to have portions of the pilot and copilot's instrument panels demountable from the front so that you could get your hand in behind there."*

Gene Baker: "There have been several suggested solutions, one of which you just mentioned. The other is to have instruments that can be removed from the front of the panel. In the present installations, the radome is bolted to the forward bulkhead and those bolts can be reached through an access door on the bottom and two access plates on top. After removal of the bolts, the radome can be removed and you then have access to the instruments. The radar absorption screen can be mounted on a thin plate or in some like manner be made easily removable. The instruments are more difficult to reach, but in practice not quite as difficult as it first appears."

Rolland S. Mangel: "Going back to the question of materials, I'd like to say that with a sandwich dome you do get better transmissivity. Depending on the installation, that may or may not be important."

Bert Rashkow: *"How thick would the sandwich dome be?"*

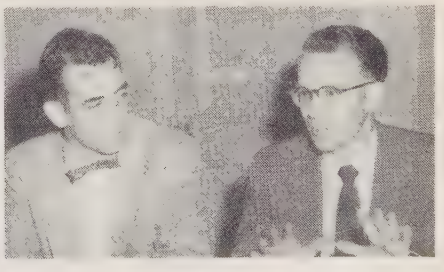
Rolland S. Mangel: "That depends on frequency."

George Church: "With C-band, it is about 5/8-inch. It's about half as thick as X-band; in other words, it's 5/8-inch at C-Band and, roughly, 3/8-inch for

(*Continued on page* 34)

"FAST ERECTION *circuitry is not necessary," stated Gene Baker (right)*

"ADJUSTMENTS *can be made on the antenna for azimuth zeroing," stated Don Ladd*



"THE NOSE *of the B-23 was extended some 28 inches," reported Cal White (left)*

SKYWAYS FOR BUSINESS

News Notes for Pilots, Plane Owners Operating Aircraft in the Interest of Business

Maintenance and Operations Meet Draws Business Pilots

Reading, Pa. The sixth annual Maintenance and Operations Meeting, sponsored by Reading Aviation Service, Inc., recently drew over 300 airplanes and 800 aircraft owners and pilots to Reading Municipal Airport.

Highlight of the meeting was the presentation of Reading Aviation Awards for high standards of excellence in Industrial, Executive and Private aircraft. The winners:

Single-Engine Aircraft

Best Exterior—France Packing Co. Ercoupe (Philadelphia). Pilot-owner: E. A. France.

Best Interior—Navion owned and flown by H. V. Beronius, Jr., Detroit.

Best Equipment & Presentation—Bonanza owned and flown by R. C. Jarecki, Erie.

Best of Class—Bonanza owned by Character Foundations, Inc., New York; pilot, Capt. Herman Kress.

Multi-Engine Aircraft (Under 12,000 lbs)

Best Exterior—Beech D18S owned by Dairypak, Inc., Cleveland. Pilot: Capt. P. Van Treuren.

Best Interior—Beech D18S owned by Virginia Coal & Iron Co., Philadelphia. Pilot: Capt. Charles Sowa.

Best Equipment & Presentation—De Havilland *Dove* owned by Precision Casting Co., Syracuse. Pilot: Capt. Dick Dower.

Best of Class—Dairypak Twin Beech.

Multi-Engine Aircraft (over 12,000 lbs)

Best Exterior—DC-3 owned by Sun Oil Co., Phila. Pilot: Capt. Ray Higgins.

Best Interior—DC-3 owned by Davison Chemical Co., Baltimore. Pilot: Capt. Ed McFee.

Best Equipment & Presentation—Douglas B-23 owned by Pittsburgh Consolidation Coal Co., Pittsburgh. Pilot: Capt. L. Ramey.

Best of Class—Sun Oil Co. DC-3

Sponsoring the awards were Air Associates, Assoc. Aviation Underwriters, Cities Service Oil Co., Lycoming-Spencer, Reading Aviation Serv., and Reading Batteries, Inc.

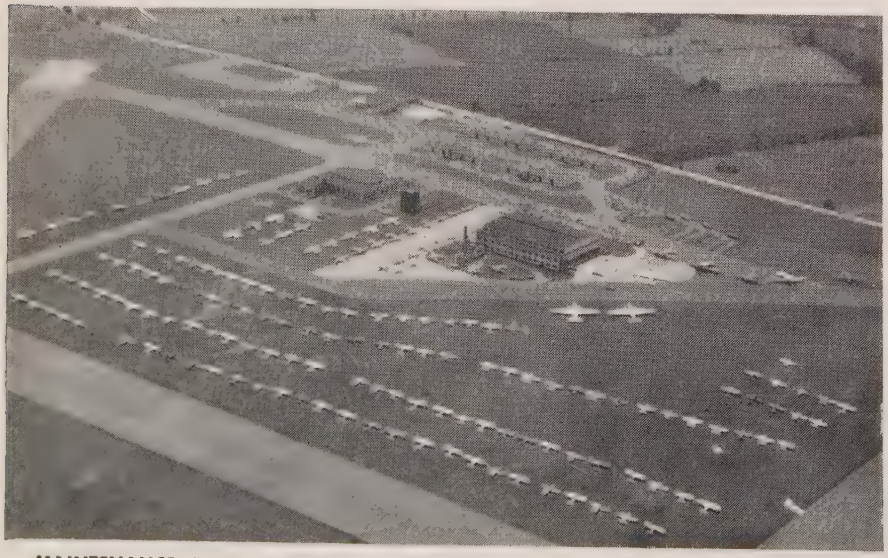
Janitrol Division Offers Heating Equipment Catalog

Columbus, Ohio. Business aircraft owners will want a copy of Janitrol's new 58-page catalog which describes all Janitrol models of aircraft heating equipment and accessories in great detail and which gives installation and engineering data and drawings. Designed to serve as a helpful and useful tool and purchasing guide for those who own and operate aircraft, the new Janitrol catalog is a "must" for pilots and plane owners in the business-aircraft field. A veritable primer on the whole problem of heating aircraft, it belongs on all reference shelves as a source book offering aid in the purchase and installation of Janitrol's equipment. Robert B. Hitchcock, Janitrol's manager of publications, deserves an "Oscar" for bringing out this useful handbook. Write Janitrol Aircraft-Automotive Division of Surface Combustion Corp., Columbus 16, Ohio, for a copy.

Bell Delivers First New Executive Helicopter

Fort Worth, Texas. The first of Bell Aircraft's new, streamlined executive helicopters recently was delivered to the President of Colombia, Gen. Gustavo Rojas Pinilla who will use the copter for both business and personal transportation.

Painted in the national colors of Colombia with matching leather and fabric upholstering in the cabin interior, the Bell Model 47H-1 offers improved performance and greatly increased comfort.



MAINTENANCE AND OPERATIONS MEETING, *sponsored by Reading Aviation Service, attracted some 300 industrial, business, private planes to Municipal Airport*

EXECUTIVE *copter interior is done in leather, fabric to match exterior paint*

Port of N.Y. Authority Offers Revisions to Schedule of Charges

New York, N. Y. The Schedule of Charges for Teterboro, LaGuardia and N. Y. International Airports has undergone revisions, effective May 1, 1955:

Teterboro, N. J.

1. For each take-off of aircraft exceeding 2500 lbs but not exceeding 7500 lbs of maximum gross weight for take-off $2.50 (Operators of aircraft of this weight class may elect to pay a fee of $10 per month or $100 per year per aircraft for unlimited use of public landing area in lieu of above charges)
2. For each take-off of aircraft exceeding 7500 lbs:—$0.02 per hundred pounds of maximum gross weight for take-off, provided minimum charge for each such take-off shall be $2.50
3. Operators of aircraft not exceeding 2500 lbs of maximum gross weight for take-off shall be permitted free use of public landing area.
4. Maximum gross weight for take-off shall mean maximum gross weight which an aircraft may lawfully have, at time of leaving ground at any airport in the U.S. (and under most favorable conditions which may exist at such airport and without regard to special limiting factors arising out of particular time, place or circumstances of the particular take-off, such as runway length, air temperature, etc.). If such maximum gross weight is not fixed by or pursuant to law, then said phrase shall mean actual gross weight at take-off.
5. Such charges shall not be payable in connection with the following:
   a. "touch-and-go" and similar operations in which aircraft comes in contact with runway or ground and, without coming to a stop, resumes flight by leaving ground from same runway and in same direction, provided the aircraft begin and ends its flight at

the air terminal and provided initial take-off is subject to such charges.

b. Test flights which originate and terminate at air terminal, provided: 1) repairs and/or work under test have been performed by a Port Authority permittee at the air terminal; 2) no intermediate landings take place at other air terminals; 3) not more than 2 hours elapse between time an aircraft is duly authenticated for test flight by PA permittee following repairs and/or work and the time the aircraft returns.

c. In the event an aircraft departs from the air terminal for another destination, which aircraft, without making a stop at another airport, is forced to return to and land at air terminal because of meteorological conditions, mechanical or operating causes or for any similar emergency or precautionary reason, such charges shall not be payable in connections with subsequent departure of such aircraft or a substituted aircraft.

LaGuardia Airport

1. For each aircraft take-off:—$0.02 per hundred pounds of maximum gross weight for take-off of such aircraft, provided that the minimum charge for such take-off shall be $2.50
2. Same as #4 (Teterboro)
3. Same as #5-c (Teterboro)

N. Y. International Airport

1. For each aircraft take-off: 27.5 cents per thousand pounds of miximum weight for take-off of such aircraft, provided the minimum charge shall be $2.50
2. Same as #4 (Teterboro)
3. Same as #5-c (Teterboro)

Aircraft Parking, Storage Area Charges

Time during which an aircraft is on the air terminal following the preceding landing and prior to its next take-off:

1. Free Time not over 1 hr. ..... no chg.
2. Additional Time

	1st 8 hrs. or fraction	additional 8 hrs.
a. each aircraft not exceeding 5,000 lbs max gross/take-off	$2.00	$1.00
b. each aircraft exceeding 5,000 lbs but not exceeding 10,000	2.50	1.50
c. each aircraft exceeding 10,000 but not 15,000 lbs	3.00	2.00
d. each aircraft exceeding 15,000 but not 25,000 lbs	3.50	2.50
e. each aircraft exceeding 25,000 but not 50,000 lbs	4.00	3.00
f. each aircraft exceeding 50,000 but not 75,000 lbs	4.50	3.50
g. each aircraft exceeding 75,000 but not 100,000 lbs	5.00	4.00
h. each aircraft exceeding 100,000 lbs	7.00	6.00

. . . . in the business hanger

Air Reduction Company, New York, has taken delivery on a new executive DC-3 from Remmert-Werner. The -3 is equipped with Skydrol hydraulic system, Skylac surfaces, Sperry H6B gyro horizon, C4 gyrosyn compass, dual Bendix ADF, Collins VHF communications and dual omni, with Bendix RMI and Omni Mag, dual Collins 51V glide path, Bendix marker, ARC isolation amplifier, Grimes rotating beacon, Edison fire detectors, Aeroquip engine lines, Goodrich brakes, Scott high-pressure oxygen system and an SAE instrument panel. William B. Lawrence is pilot and Robert Cantarera, copilot. The new -3 is based at Westchester County Airport, N. Y.

All American Engineering Co., Wilmington, Del., has added a Mooney *Mite* to its fleet of business aircraft. The company now operates a Piper *Tri-Pacer*, a *Bonanza*, a Bellanca *Cruisair*, an experimental Piper PA-11 and the *Mite*. All aircraft are based at New Castle County Airport.

Walter A. Jensen has joined Parker Pen Co., Janesville, Wis., as a pilot in the firm's aviation department. He is a former flight supervisor with the CAA. Parker Pen operates three business aircraft and is a member of the National Business Aircraft Association.

Barber Oil Company's DC-3 has been in the hangar at AiResearch, Los Angeles for a complete executive interior featuring picture windows. New long-range wing tanks, a completely new radio system and Wright 1820-76 engines also are being installed.

Ed Armstrong and Jim Smith flew S. W. Richardson's two DC-3's from Fort Worth to Dallas and Executive Aircraft Service for 100 hour inspections, miscellaneous repairs and installation of new short stacks.

The Rugene Transportation Company's executive DC-3 has been at Dallas Avionics for installation of dual Bendix ADF, dual omni, an Eclipse-Pioneer Fluxgate system, and an auxiliary 20-channel VHF transmitter.

The Steuart Petroleum Corp., Washington, D.C., has just purchased a D18S from Atlantic Aviation Service, Wilmington, Del. Dewey Peterson is chief pilot for the petroleum company.

Larry Montigny, Dresser Industries' pilot, Joey Uhler, his copilot, and Sandy Sanford, mechanic, brought DI's PV-1 to Southwest Airmotive for 100 hour check.

A Flite-Tronics MB-3 marker beacon receiver has been installed in the Beech E18S owned by Luft Fahrt-Technik, G.m.b.H, Koln-Ehrenfeld, Germany. The equipment was purchased from Beechcraft's Export Div.

Aaron Spotswood brought Monsanto Chemical Company's Twin Beech to Engine Works, St. Louis, for a double engine change. Monsanto is a member of NBAA.

National Supply Company of Pittsburgh has its Martin 404 in operation after a new exterior paint job and installation of a beautiful executive interior. Chuck Hanner rides the front office of the 404 and is National Supply's chief pilot.

The Ford Motor Company of Canada, Ltd., has just acquired a new Super-92 DC-3 from Remmert-Werner. The plane carries 14 passengers at average speeds of over 200 mph and features an executive interior as well as all the latest in radio and electronic equipment. Jack Clark and David Griffin are pilot and co-pilot of the new -3.

N. A. Skoglund, pilot for K. S. Tractor & Implement Co., Springfield, Mo., brought his company's Twin Beech to Southwest Airmotive, Dallas, for 100 hour check and a double engine change.

Barron Hilton of Hilton Hotels, Inc., has had his de Havilland *Dove* at AiResearch Aviation Service for a new and special exterior paint job.

The Fruin-Colnon Contracting Company has had its new *Lodestar* at Remmert-Werner for installation of Collins 17L VHF transmitter, 51R3 receiver with omni, and 51V glide slope. The *Lodestar's* wings also were pulled and inspected, de-icer boots and plumbing installed, new tires, additional instrumentation, a new interior with Fiberglas insulation, and an exterior paint job. H. V. Gausmann is the pilot.

H. E. Ross brought The Pontiac Refining Corporation's *Lodestar* to Executive Aircraft Service for 100 hour inspection and repairs.

PLANE FAX

Your Best Week-end Flight Plan for July

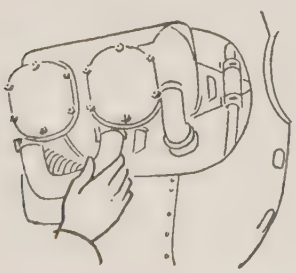
Fly to Long Beach, California, to watch the start of the Eighth Annual All-Women Transcontinental Air Race, July 2. You'll get quality Standard Aviation products and service at Long Beach Municipal Airport.

Sampling fog 500 feet over San Francisco Bay

Research takes to the air! University scientists rent a Navion from Jack Nystrom, manager of Palo Alto Airport, to flight-test "cloud-sampling" instruments above San Francisco Bay. The devices are used at 500-foot intervals, from 500 to 10,000 feet, to measure water content, impurities, and other properties of haze, fog and smog.

"Flying low over the Bay in all kinds of weather can be fun," says Jack Nystrom, "as long as I know my plane's in top condition. With RPM Aviation Oil in our engines, we have no trouble with valve sticking or rough running, and our engines never knock even during take-off or on fast climbs under heavy load."

"Whether we use our planes for smog sampling, forest patrols, or student training," says Mr. Nystrom, "we get ⅓ more flying time between overhauls with RPM Aviation Oil. It ends ring-sticking, reduces wear, and keeps our engines so clean that we save labor at overhaul. And because 'RPM' prevents pre-ignition and holds down cylinder head temperatures, we don't know what it is to have to replace pistons. They seem to stay in good condition indefinitely."



TIP OF THE MONTH

It's a good idea to check your engine's exhaust system for cracks or other leaks. They'll show a grayish lead deposit on the outside of the pipes.

T.M.'S "RPM," "CHEVRON," REG. U.S. PAT. OFF.

CHEVRON AVIATION GASOLINE

RPM AVIATION OIL

STANDARD OIL COMPANY OF CALIFORNIA

FUELS-OILS

Features and Facts Pertinent to Successful Flight Operations

S.F. Int'l Gets Super-Size Standard of Cal. Fuel System

A $631,000 underground fueling system, described as "the largest and most modern in the world," has been placed in operation by Standard Oil Co. of California at the San Francisco International Airport. F. R. Meyer, Standard of Cal's San Francisco district manager, described it as "a necessary adjunct to the new $11,000,000 terminal building."

Actually, the new system is an adjunct to the future as well, if its size is any gauge. It is a hydrant-type system which can supply virtually unlimited quantities of fuel at the rate of up to 400 gallons per minute at each fueling station. Its fuel load possibilities, far greater than any current demands, are clearly designed for the future needs of larger, longer flying airliners.

Here is how the new system shapes up:

First element is the main tank storage facility. This is a bulk plant that is located close to the seaplane harbor and which has storage capacity for about 1,400,000 gallons. The fuel for this first stage of storage is delivered by barge from Standard's Richmond Refinery.

Next comes a satellite storage system. This is supplied from the main tank farm through two pipelines of three- and four-inch size and 9300 feet long.

The two 150-gallon-per-minute pumps in the main tank farm area handle the transfer process. These pumps, however, are controlled from the satellite storage area itself.

As an example of the eye-to-the-future planning of the entire system, additional lengths of four-inch pipe have been installed wherever the transfer pipelines run under pavements. This way, if future expansion of the transfer system is demanded, couplings can be made to these extra lines without disrupting permanent surfaces.

The satellite storage system consists of eight 25,000-gallon tanks at the end of the new terminal concourse. Pumps, filters, water separators, and controls are also here. (The pumps are automatic and the filters are micronic.)

Capacities of the pumps and the products they will handle are: 3 for 100 octane fuel at 1200 gpm; 2 for 115 octane fuel at 800 gpm; 2 for 108 octane at 800 gpm; and one for 91 octane at 400 gpm.

The designations of the basic fuels for the system, of course, will be that of Chevron Aviation Gasolines, 91/98, 100/130, 108/135, and 115/145.

From the satellite area, five large pipelines supply four grades of fuel to the individual concourses of the field. Again, the future planning is evident. Although only three concourses have been built by the airport so far, pipe tees have been installed in the concourse pipelines system so that, at any later date, fuel can be directed to new concourses around the airport.

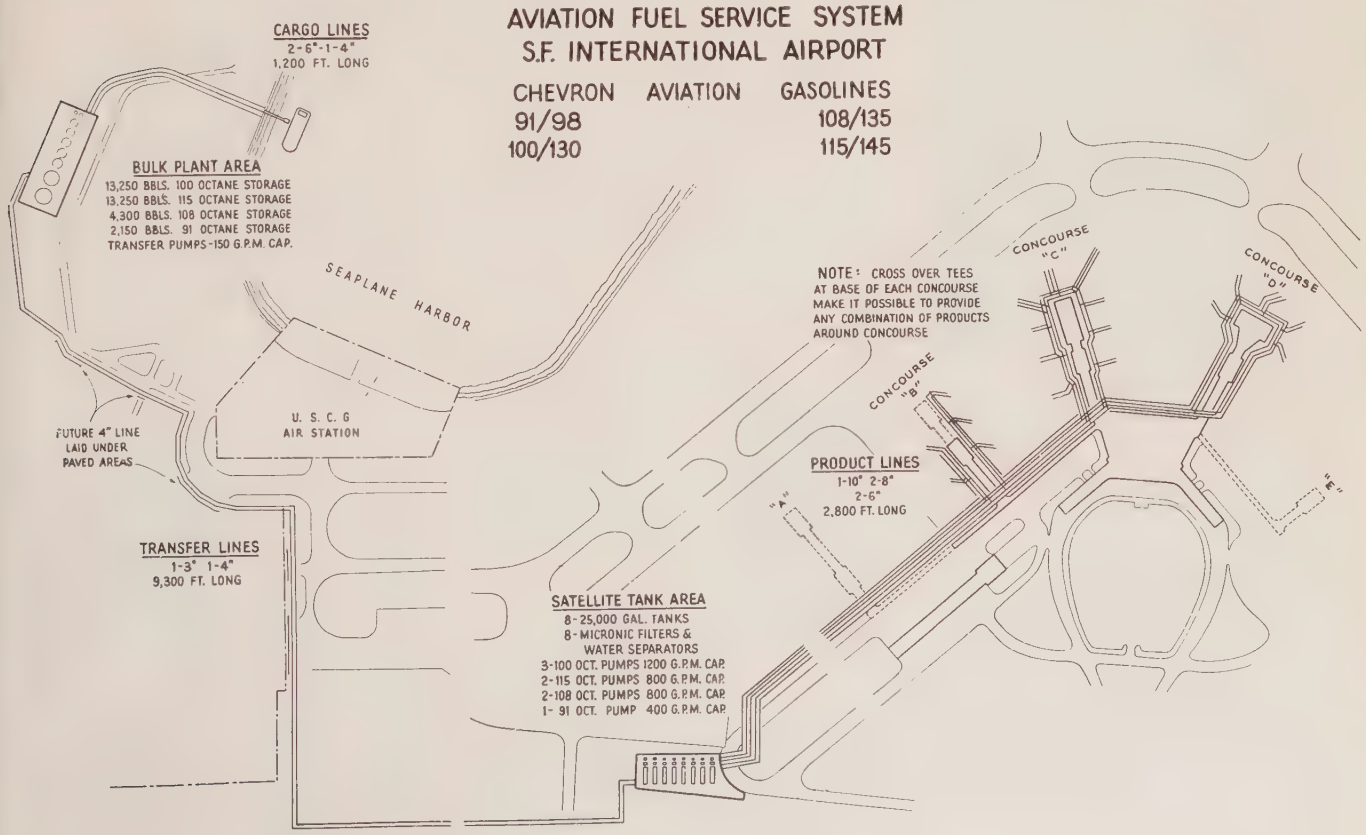
Concourse "C" of the new system will be used exclusively by United Air Lines. Because of this, that airline has installed its own pipelines around "C" at nine airplane parking positions. Two grades of fuel are available at six positions with three grades available at the three end positions.

Around Concourses "B" and "D", Standard of California has put three of its own six-inch pipelines.

Hydrants are provided for two grades of fuel at each of five positions on Concourse "B" and an equal number on Concourse "D". However, an outlet for a third grade of fuel supply has been installed for international air carriers that may, at a later date, require jet fuel.

Until the time that this jet-fuel demand materializes, the jet portion of the system will be kept in operating trim by putting 91/98 Grade avgas through it.

Fueling carts for the hydrant system have been designed by both United and Standard to meet their specific needs. Standard's, of course, will be available on a lease basis to other lines who do not care to design and build their own. For both self-propelled and hand-drawn carts,



the same basic equipment for fueling aircraft is provided: hoses, nozzles, meters, air-eliminators, shock absorbers, micronic filters, and flow regulators. The hydrant valves are quick-connecting, dry-break, two-part devices, one half being connected to underground pipelines located just below the surface of the paving. The other half is attached to the cart connecting hose. Neither half can be opened when disconnected. Thus the system permits connecting and disconnecting of cart and pipeline without loss of gasoline.

This is the way the system operates: Fuel from the barge goes directly into large receiving storage tanks. After the fuel has been allowed to settle, any possible water or sediment received from the barge along with the fuel is drained off through a bottom outlet valve. As further protection, the fuel is withdrawn through a floating outlet valve and pumped into a work tank from which fuel is drawn through the transfer lines into satellite storage tanks. Transfer pumps are automatically stopped when a predetermined amount of fuel has been received. For protection against the possibility of human error, the automatic stop system will also operate when the satellite storage becomes full.

When the aircraft is ready to be fueled, one or two fueling carts are connected to the hydrant valves in the plane parking position. The hydrant valves are located in the pavement just outside of the outboard engines on each side of the airplane. The fuel then flows from the satellite tanks through pumps, micronic filters, water separators, and pipelines to the hydrants and through the cart delivery facilities to the airplane.

The 100/130 avgas system has three 400 gpm centrifugal pumps with automatic pressure cut-in and cut-out controls so that delivery rates from zero to 1200 gpm can be obtained as required. The 108/135 and 115/145 avgas systems are now set to deliver up to 800 gpm, with the 91/98 avgas system delivering 400 gpm. Additional pumps can be added if increased flow rates are needed in the future.

Individual explosion-proof pump starting buttons are located at hydrants on both sides of the airplane in each plane parking position. Emergency stop switches are placed at convenient locations. Automatic time delay switches stop the pumps after they have run in a "by-passing" condition for a minimum of 15 minutes.

Ethyl Corp. Reshapes Its Sales Organization

A realignment of the sales organization of Ethyl Corporation has been announced by Malcolm P. Murdock, vice president in charge of sales. The organizational changes follow the formation of Ethyl Corporation of Canada, Ltd., which will direct the manufacturing and marketing of "Ethyl" anti-knock compound throughout Canada.

Two new positions have been created. S. T. Pruitt has been named domestic sales manager and will have charge of all domestic sales of "Ethyl" anti-knock compounds. Harold R. Berg, after an extended leave of absence, will assume new duties as sales coordinator.

Stuart Forbes succeeds Mr. Pruitt as manager of Ethyl's Central region; Leonard L. Huxtable has been named assistant manager of Ethyl's Southern region, and Laurence Reis has been appointed district manager of the Tulsa office.

Jet Fuel Safety Factors #2 Reviewed by the Oil Institute

In its second review of American Petroleum Institute recommendations concerning jet fuel safety factors, SKYWAYS takes up the three distinct areas of spillage, health hazards and contamination.—Ed.

To the many persons handling jet fuels, the fact that the fuel does not contain tetraethyl lead induces a notion that there are no contact or inhalation problems as compared to Avgas. Nothing, the American Petroleum Institute's Aviation Technical Service Committee has reported, could be farther from the fact. Jet fuels actually may contain more toxic aromatics than regular aviation gasolines.

The same general health precautions that apply to the handling of avgas should be applied just as rigidly to the handling of jet-type fuels.

The fuels should not be used for cleaning purposes.

Excessive inhalation of vapor should be avoided.

Excessive skin contact should be avoided.

If jet fuel is spilled on a handler, skin should be washed thoroughly with soap and water as soon as possible. Clothing on which jet fuel has been spilled should be removed as soon as possible and thoroughly laundered.

When it comes to plain spillage of jet fuels, there actually is a more acute problem than with ordinary aviation fuels. The jet-type fuels do not evaporate as rapidly as avgas. They do, however, have a pronounced tendency to soften asphalt.

The warning is clear: "Spillage of jet fuels on asphalt runways is a No. 1 "DON'T."

Contamination of fuels themselves introduce special problems and special precautionary demands. The more usual contaminants such as dirt, water, rust, or scale present a sizeable hazard to jet fuels. In the high-precision mechanisms of a jet engine, they are sure-fire function-stoppers. Even minute dust particles may dangerously accelerate clogging of fuel filters, not only because of the dust itself but because each particle acts as a nucleus around which ice crystals may form.

Water is a greater hazard in jet-type fuels than in regular avgas because it will not settle as rapidly in the jet grades because of the higher specific gravity of jet-type fuels. And, in turn, the larger temperature differentials in jet aircraft operation over that of piston engine operation means that entrained and even dissolved water in jet fuel is a more critical problem.

When it comes to contamination of jet fuel with moderate proportions of avgas, there is a turn-about warning. The avgas in the jet fuel will not normally affect jet-engine performance too drastically *if* the proportions are moderate. But, if only a very small amount of jet-type fuel is introduced into regular avgas, the anti-knock value of the avgas will be reduced seriously, and operating performance may be affected critically. The amount of jet fuel that will cause this situation may be so tiny that a laboratory analysis would be the only way of detecting it.

Contamination of jet-type fuel by either piston or jet-engine lubricating oil may not cause trouble in the jet engine but, the American Petroleum Institute warns, "such contamination should be avoided."

Quite serious in possible effect and most strenuously to be avoided is the contamination of jet-type fuels with hydraulic fluids and other "specialty" products. Many of these are of a non-petroleum origin and could seriously and dangerously affect jet-engine performance.

CAA Warns Against Auto Fuel in Aircraft Engines

With the octane rating of currently produced automobile gasolines soaring up into the areas usually associated with aviation fuels, more and more private plane owners have speculated on using the corner gas station's product as avgas. Some highway filling stations, in fact, have been boasting about their pumps offering "aviation gasoline."

As a result, A. S. Koch, director of the Office of Aviation Safety of the CAA, has issued a special warning. "We are receiving," Koch says, "numerous reports of owners attempting to save money" by using automobile fuels in aircraft power plants.

Koch explains that "automobile gasoline has a vapor pressure of 8 to 13 pounds, while aviation gasoline has a vapor pressure of 5 to 7 pounds. The low vapor pressure in the aviation gasoline is insurance against vapor lock caused by altitude and heat. With the approach of summer weather, the hazards of vapor lock are sharply increased, and safe flying demands the right kind of fuel for aircraft engines."

Jet Fuel Stability Is New Refining Goal

Operation of supersonic jet aircraft has produced a striking new series of contradictions for the fuel used in the aircraft. First, it has been discovered that the fuel itself should be used as a cooling agent. Burned and blown from the jet, the fuel can soak up and remove excess engine heat. Yet, as petroleum engineers know, heating petroleum fuels for a short span of time is a standard method of speeding up gum and sediment formation in petroleum. Thermal stability of jet fuels, thus, has become a key problem.

The use of additives to achieve this stability in fuels generally has been one major approach to the problem. The severe demands of jet fuels, however, have seemed to over-power that approach. Now, along a different line, Socony-Mobil has announced significant successes. The Socony approach has been through the refinery processes in which the fuel actually is formed. The specific process involved in the initial announcement of their work is "hydrocracking." In this process, jet fuel feed stocks are cracked catalytically (and using a new Socony catalyst) in the presence of hydrogen at relatively high pressures and temperatures.

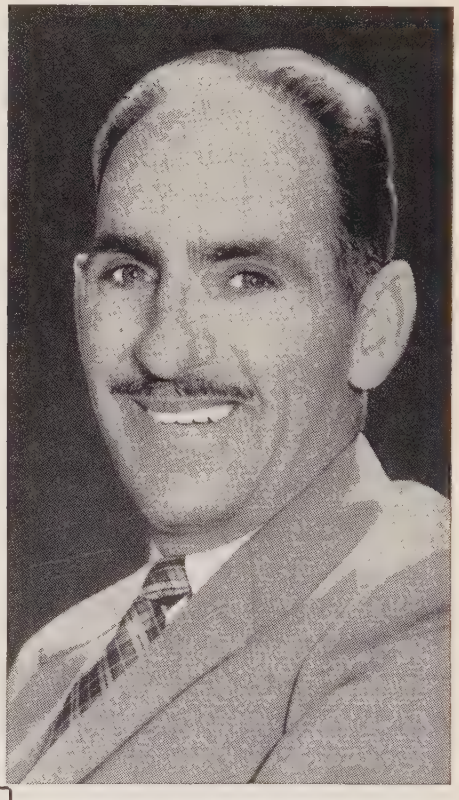
(Readers familiar with German research of World War II will recall that

(Continued on page 37)

Mr. Davis and a Ryan Navion plane he has flown over most of the United States.

Ask the men with the most experience . . .

ask **Ralph W. Davis,**
vice-president of
Elwin G. Smith Company,
Pittsburgh, Pennsylvania



"I've used Gulf Aviation Products exclusively for the last six years," says Mr. Davis. "In my book they're tops . . . especially *Gulf Aviation Oils*. I like Gulf's oils because they do two jobs at the same time—they *protect* my engine while they lubricate.

"I like the protection of Gulf's *Micronic Filtration* on fuel pumps, too. Those filters on the Gulf pumps that prevent water and foreign particles from getting into your tank and fuel system certainly eliminate a lot of real trouble. You can give me Gulf's '*refinery-clean*' fuel every time."

Gulf Aircraft Engine Oil, Series-R

For radial engines, or where a detergent oil is not desired. Approved by Pratt and Whitney and other radial engine manufacturers for all types of service.

Available in SAE grades 30 through 60.

Gulfpride Aviation Oil, Series-D

For horizontally opposed and Ranger inline engines. Users of this great detergent oil have increased periods between engine overhauls by as much as 100%.

Available in SAE grades 30 through 50.

AND *Gulf Aviation Gasoline* . . . it comes to you "refinery clean"—for your safety—from pumps with advanced *Micronic Filters*.

GULF
AVIATION PRODUCTS

GULF OIL CORPORATION
GULF REFINING COMPANY

Official NBAA Report

NATIONAL BUSINESS AIRCRAFT ASSOCIATION, INC.

(formerly Corporation Aircraft Owners Association)

National Business Aircraft Association, Inc. is a non-profit organization designed to promote the aviation interests of the member firms, to protect those interests from discriminating legislation by Federal, State or Municipal agencies, to enable business aircraft owners to be represented as a united front in all matters where organized action is necessary to bring about improvements in aircraft equipment and service, and to further the cause of safety and economy of operation. NBAA National Headquarters are located at 1701 K Street, N. W. Suite 204, Washington 6, D.C. Phone: National 8-0804.

VOR/DME Issue Vital To All Business Flying

Since reporting last month on the status of the VOR/DME-TACAN controversy, NBAA has obtained considerable information bearing on this national issue. For all interested in the future of civil aviation, we are presenting a summary of the most recent developments.

Following is an extract from the recent "*Report of the Committee on Interstate and Foreign Commerce—Investigation of the Development of the Common System*" (Report 592). It contains the findings and recommendations of the subcommittee on Transportation and Communications.

"Your Committee on Interstate and Foreign Commerce, having considered the report of its Transportation and Communications Subcommittee on an investigation of the development of a common system of air navigation and traffic control, submits the following report:

"The present nationwide system of short-range air-navigation aids for joint use by civil and military aviation was developed as the result of a study made in 1947 by a subcommittee of the Interstate, and Foreign Commerce Committee of the House of Representatives. That subcommitee in Report No. 885, 80th Congress, submitted July 11, 1947, recommended development of—a single system which will safely and economically serve the requirements of both commerce and national defense simultaneously.

"Recent developments have placed the concept of a common system in jeopardy.

"The controversy came to public notice as a result of a press release issued on February 8, 1955, by the ANDB, which revealed that a new Rho-Theta short-range radio air-navigation system, known as TACAN, was under consideration to replace the system now in operation, commonly known as VOR/DME.

"February 11, Fred Lee, Administrator of Civil Aeronautics, was before the Interstate and Foreign Commerce Committee, he was questioned by Hon. J. Percy Priest, Chairman, regarding ANDB release. When it developed that matters of classified military information were involved. Chairman Priest suggested the subject be passed until an executive session be arranged.

"Subsequently, the Transportation and Communications Subcommittee was directed to conduct a thorough investigation of the controversy. The first hearing was held in executive session on March 10, when Hon. Donald A. Quarles, Assistant Secretary of Defense (R. and D.), and representatives of the Department of Defense appeared.

"Further hearings were held in executive session on March 1 and 15 and on May 3, to hear testimony involving classified military information. Representatives of the civil users of airspace were heard in open hearings on March 25 and April 11. Testimony was heard from spokesmen for various points of view, civil and military.

Findings and Recommendations

"1. The position taken in 1947 by this committee that there must be but one system of aids to air navigation and traffic control common to all users of the airspace in the United States and not a multiplicity of systems, is reaffirmed. A multiplicity of systems would constitute both a hazard of large proportions and a burden upon the taxpayers. We insist that coordination among the Government Agencies concerned be maintained to prevent overlapping and duplication of effort in the development of the common system concept.

"2. Subject to the policy declared in Paragraph 1 above, the Subcommittee on Transportation and Communications concurs generally in the ACC program on electronic short-range navigation systems, announced April 20, 1955, with an important exception, namely:

"The subcommittee recommends that after 1958 DME ground equipment be continued in operation on a year-to-year basis only. Civilian users already have important investments in DME airborne equipment and would make additional investment if led to the belief that continuation of DME to any fixed date beyond 1958 is assured.

"3. The appropriate agency should undertake immediately the development of airborne units for civilian use with TACAN ground facilities. These units should have cost and performance characteristics compatible with the intended user's needs and the requirements of flight safety and should include miniaturized versions suitable for use by private pilots.

"4. The Department of Defense is urged to declassify TACAN completely."

NBAA Stand on General Arnold Statements

NBAA, in connection with the above hearings, took exception to certain statements made by Milton W. Arnold, Vice President, Operations and Engineering, ATA, in his letter to the members of the House Subcommittee on Transportation and Communications concerning the top ACC action of April 20, 1955. Quoted below is our letter to the same Committee Members:

"Copies of a letter dated April 22, 1955, which Mr. Milton W. Arnold, Vice President, Operations and Engineering, Air Transport Association of America (ATA) addressed to your Committee, with regard to the above-entitled action, have been furnished to the Washington National Headquarters of the National Business Aircraft Association (NBAA).

"The NBAA finds it difficult to understand Mr. Arnold's utter refusal to accept the government policy which has now been adopted by the ACC and which is predicated on the agreement reached by its Air Traffic Control and Navigation Panel after searching reappraisals of all of the facts, both classified and otherwise, which pertain to the VOR/DME-TACAN controversy. Indeed, all branches of the Military, the Civil Aeronautics Board, Civil Aeronautics Administration, Department of State, Federal Communications Commission and the many other representatives of civil aviation who served on the ACC NAV panel unanimously agreed to the policy which Mr. Arnold now advises he does not approve.

"Apparently Mr. Arnold believes that the ACC action of April 20, 1955, will '(a) increase the burden and inconvenience to users, should TACAN be accepted as the common civil/military short-distance aid in the near future, and (b) in the meantime, cost the taxpayer large sums of money without adequate justification.'

"With regard to (a), supra, *'The burden and inconvenience to users' will occur only in the event of the adoption of any system that might later be determined to be superior to the present system. Certainly at this time there can be no assurance whatever that TACAN will be adopted! The study and evaluation by the Air Navigation Development Board's VORTAC Panel, of which Mr. Arnold was Chairman, formally found that TACAN was not fully developed and that it probably would be three years before its development could be completed and its implementation begun. Furthermore, Colonel J. F. Taylor, Director of the ANDB, publicly emphasized that TACAN was by no means being recommended for adoption as the common system but that such adoption was merely an objective which depended upon 'substantial uncertainties to be explored and resolved.'*

"The NBAA contends that the real burden and inconvenience to users would come from Mr. Arnold's plan of decommissioning a present *system which is now in use and which will continue to be a vital necessity to air safety until TACAN or some other common system can be developed. The tax-*

payers already have an investment of some $117 million in the present system and such investment certainly should be protected until a better common civil/military system can be perfected.

"With regard to Mr. Arnold's claim that the ACC release, paragraph 1-B.3, alters the firm program which previously had been established for VOR, the NBAA feels that the ACC's latest phraseology is eminently more intelligent than a brash promise to continue VOR for a definite and specific length of time regardless of how rapid the pace of new developments in the electronics field might be.

"By his recommendation that the CAA should discontinue the operation of civil DME system as of June 30, 1955, but maintain the ground DME equipment in readiness for use, Mr. Arnold, of course, admits that the ground DME equipment which is already bought and paid for may be needed at any time. Hence, his suggestion to decommission an existing and highly useful navigational system, when there is no system yet developed that can replace it, would seem highly improvident if not actually dangerous. What would the users of the airspace do during the interim period to insure safety in navigation and air traffic control?

"The verity of Mr. Arnold's suggestion that the scheduled airlines and the military services believe that civil DME will contribute relatively little to the improvement of air traffic control would bear checking with the CAA which Government Agency has sole jurisdiction over and is the best authority on the problem of air traffic control.

"With regard to the suggestion that those segments of civil aviation which advocate the continued use of civil DME admit its value will be confined primarily to its use as an aid to navigation, the NBAA wishes to take specific issue. To the knowledge of NBAA no such admission could be factually made. DME is essential to having a definite airspace fix, particularly at holding points in areas of high-density traffic and it, therefore, is a safety factor of high priority. Turboprop and jet aircraft are in our skies today; their speed and fuel limitations demand distance information.

"As to whether the continuance or expansion of DME would require the expenditure of relatively large amounts of money that should otherwise be used to relieve serious air traffic control deficiencies, as Mr. Arnold suggests, the NBAA again submits that the testimony of CAA will be the best evidence of how DME may best fit into the air traffic control picture. Under present-day conditions, what is the assurance that the decommissioning (and keeping on a stand-by basis for possible future use) of a system, already paid for, would result in making funds available for investment in other air traffic control needs such as radar, overloaded communications channels, etc.? Without doubt, long-range radar, improved communications and the other developments and installations suggested by Mr. Arnold are necessary, but just leaving present equipment idle could not finance such additional needs. In any event, as the NBAA sees it, this suggestion of Mr. Arnold's would merely be a method of 'robbing Peter to pay Paul,' and the NBAA does not agree that such a method would be the cheapest and safest way to bring those necessary advancements.

"Effect of Mr. Arnold's suggestion of international complications also should be given due weight. Although your Honorable Committee already is well aware of that phase of VOR/DME-TACAN controversy, it probably should be noted here the Department of State, The Civil Aeronautics Board, and the Federal Communications Commission, through the Air Traffic Control and Navigation Panel, supported a reversal of the VORTAC recommendation."

Developments in the House

Other developments of importance on the issue also occurred in the House. Rep. Chet Holifield (D-Calif.), Chairman of the House Subcommittee on Government Operations which held hearings on the military expenditures for TACAN since its inception, introduced two resolutions (House Concurrent Resolution 128), one which supported Senator Styles Bridges' (R-N.H.) Senate-approved resolution calling for a joint congressional investigation (*NBAA report, April SKYWAYS*) of VOR/DME-TACAN and the whole air-navigation system. The second resolution (H. Con. Res. 132) requests the President to review the functions of the Federal Agencies responsible for the development and implementation of air-navigation facilities, in light of the inter-agency disagreement over continuing DME. If necessary, certain agencies might require reorganization to prevent future confusing occurrences of the VOR/DME-TACAN type.

During the debate in the House of Representatives on appropriations for the Commerce Department which included CAA funds for continuation of DME (as recommended by the top ACC), several heated discussions took place on the floor regarding the VOR/DME-TACAN battle. Speaking on behalf of the non-airline civil aircraft users, on the minority party side, Rep. Sidney Yates, (D-Ill.), criticized the airlines for refusing to equip their aircraft with the necessary aids to utilize Federal ground air-navigation facilities. He stressed that "some way has to be found now to require the airline carriers to install DME equipment, and I would urge the CAA to do so as quickly as possible."

On the majority party side, Rep. Walt Horan (R-Wash.), told the House Members that careful study of the two systems prompted the conclusion that "we had better go slow with TACAN" and that the whole matter should be investigated "preferably by the CAA."

In response to NBAA's strong request to the House Interstate and Foreign Commerce Committee Chairman J. Percy Priest (D-Tenn.), to pry loose the Bridges resolution from the House Rules Committee for early action by the House, we received a polite brush-off. He stated, in connection with House Report 592 previously summarized, that "it is my considered judgment that this study has been as extensive as any study that could possibly be made at this time." NBAA is incontrovertibly opposed to shutting off a complete and far-reaching investigation of the common system issue as proposed by Senator Bridges. Certainly a full and impartial airing of the technical, contractural and financial steps leading up to the controversy and a forecast of its ultimate effect on civil aviation is imperative to protect the innocent "victims" of the controversy.

NBAA will continue to vigorously champion the passage of the Bridges resolution by the House to assure the protection of business flying interests.

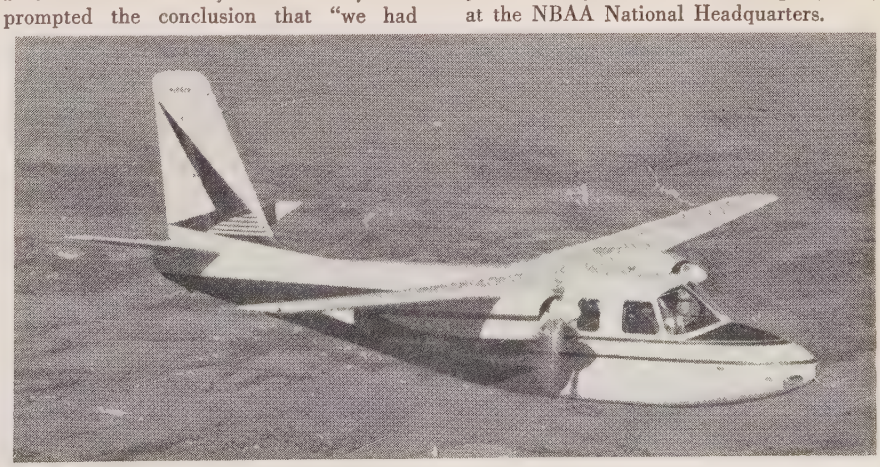
Business Flight Safety Award

The National Business Aircraft Assn. is privileged to administer the awarding of the Kansas Women's Aeronautical Assn.'s Annual Business Flight Safety Award.

This WAA Flight Safety Award will be in the form of a Trophy and will be one of the highest honors for the Advancement of Business Flight Safety to be bestowed by the N.B.A.A. It may be awarded annually to that person in industry who has most effectively carried out and promoted Business Flight Safety.

Walter C. Pague, NBAA Board Member and Chairman of the Awards Committee of the Association was appointed Chairman of WAA Business Flight Safety Award Committee. Mr. Pague is Chief Pilot for ARMCO Steel Corporation, Middletown, Ohio. Adella Allen, WAA Safety Committee Chairman, is Vice Chairman. Mrs. Allen is a member of the Kansas WAA. Committee Members, representing the National Aeronautic Association, National Safety Council, the 99'ers, Flight Safety Foundation, and other national aviation organizations, will be announced in the future.

First meeting of the new Committee is planned early in June in Washington, D.C., at the NBAA National Headquarters.



AERO COMMANDER *recently was purchased by Glenn L. Martin Co. for business transport*

PLAN Your Radio

by Roch Leone

Chief, Air Radio Maintenance

RADIO has become an increasingly important factor in the safe operation of executive aircraft. Company and corporation officials who are realizing the extreme utility of aircraft in the execution of their business affairs cannot tolerate much in the way of delays or postponements of their trips because of weather. Therefore, instrument flying is a necessary requirement of the business pilot.

Most business planes are well equipped for instrument flying. In fact, the average executive airplane is the best equipped in the country, even exceeding in some case those aircraft operated by the nation's airlines. Much of the development and advancement of such aids as flight directors, Distance Measuring Equipment, and weather radar are directly attributable to the installation and operation of those aids in company aircraft. Forever aware of safety, business pilots and the owners of business aircraft are constantly on the look-out for the latest and best in radio and electronic aids to flight. Not alone because of the cost of this equipment but also because it is so vital to the successful operation of aircraft for business, it is essential that the best in the way of service and maintenance be available to keep that electronic gear in perfect operation.

Conversations with company pilots throughout the country have clearly indicated there is not a sufficient number of qualified and competent radio repair stations to meet the needs of this fast-growing class of air transportation. Perhaps unwittingly, company-plane owners and pilots themselves have helped to create this problem. To understand what toots the horns of this dilemma, consider these factors:

From purely an economic standpoint, no organization set up to offer radio service only can long endure. The cost of the equipment necessary to the proper servicing of aircraft radio is expensive. This investment plus that involved in the purchase of an inventory of spare parts, etc., and the monetary outlay for new test gear demanded by the marketing of newly developed aircraft equipment, cannot and is not covered by reasonable fees levied for service alone. Moreover, insurance rates and rentals are high, and qualified personnel is not only scarce but must be well paid if the operator hopes to keep an efficient organization together.

Therefore, the radio service operator must rely heavily on the sale and installation of new equipment in order to make the proverbial ends meet and enjoy a reasonable return on his investment.

The tendency among many clients is to shop around for whatever equipment they want and to buy it from the organization offering the lowest price. While this may seem like good business on the part of the purchaser, it doesn't always work out that way. The concerns offering low prices and/or discounts usually have no interest in servicing that equipment. Therefore, the purchaser must go to a reliable and trustworthy service organization for his maintenance, but meanwhile that service organization has not enjoyed the dollar benefits of the equipment having been purchased from them and installed.

The business-plane operator invests a tremendous amount of money in his aircraft, and the only way he can obtain the maximum utility on his investment is to keep the equipment in perfect working order. This calls for good service at his major destination points. Naturally, the individual aircraft operator cannot help all the service operators in business, but if he were to "shop" on the basis of quality rather than price alone he will have made a giant stride toward more reliable and trusted radio service.

A common method employed by aircraft operators who are installing new equipment is to allow several concerns to bid on the work. Most purchasers merely specify the equipment desired and offer a generalization as to cockpit layout, with no specifications on the actual installation. Such a method or system makes the client easy prey of the less conscientious shop operator who is always willing to do a job for a little less money. The shop operator who made his bid with high-quality standards in mind loses out.

If an aircraft owner notices a great differential in bid prices, he would be wise to question such a difference. The more conscientious operator can easily point out to the client's satisfaction that the job couldn't possibly be done for the lower bid price and still be according to the high standards by which he operates. In many cases, he can even point out how, by lowering his own standards, he could beat even the lowest bid offered.

Therefore, a partial answer to the bid problem would be to supply complete specifications. To do this, an aircraft radio consultant, one who is completely independent of manufacturers, installing agencies and dealers, should be sought out. The qualified consultant then will consider his client's needs, specify the type of equipment to serve those needs, its layout and wiring configuration, and then specify a standard of quality on materials.

Although the consultant serves an important and necessary function, he cannot rigidly control the quality of workmanship. He can merely specify standards and, in some cases, make periodic inspections of the work in progress. It is up to the client to choose the organization that best conforms to the specifications in keeping with high standards of workmanship. Such an outfit may not be the lowest bidder.

Qualified consultants are becoming increasingly available and the use of their services is strongly recommended to those business-plane operators who are thinking in terms of additional radio and electronic equipment for their company aircraft.

A little more money spent during the planning stages of the acquisition and installation of new equipment usually saves money in the maintenance or service stages. In my work at Air Radio Maintenance, I have seen several costly examples of installations made without proper planning. In one case, a company pilot brought his plane in and reported radio trouble. We bench checked his equipment, found everything completely normal, then traced his difficulties to the installation of the equipment in his aircraft. We immediately asked this pilot for his radio prints and learned he had never been supplied any.

In another case, and this one like the one just mentioned, is not an isolated instance, a company pilot came in with an inverter inoperative. After locating the inverter, it was an all-day job to remove and replace it. And labor is not an inexpensive commodity. We have had several instances when it was extremely difficult to remove the radio equipment in order to work on it. All of this is the result of inefficient installation planning, quite conceivably on the part of the service organization that "was"

the job on the basis of a low bid. The executive pilot and plane owner would have been better off had they spent a little more money on a well-planned installation.

Such an installation makes allowances for the addition of other equipment at later dates, i.e., extra rack space and spare terminals in the junction box, spare wires in all harnesses to facilitate future repairs and modifications, etc. The well-planned installation always takes into account accessibility and ease of removal for necessary service of equipment.

Whether it's by a trial and error method or through conversations with other pilots, sooner or later every executive pilot learns which service organzations have been the most satisfactory in maintaining and repairing his equipment. In my work as a technician chief in the mainteance of radio and electronic equipment, I have seen enough company-plane installations to convince me that the most expensive are those that originally, installation-wise, cost the least; and by the same token those that cost the least to maintain were the ones that originally cost something more than the least to install.

In the interest of good business, both for the plane owner and the service organization, the executive pilot would be wise to have his choice of service organization do his equipment installation work as well—and that decision to be based not on the low-dollar bid but on the quality of service. Because a service organization knows from experience what are good and bad installations, that organization plans for ease of maintenance and modification and, economically as well as operationally, is the logical one to assure a good installation. +++

Steam Catapult

(*Continued from page* 13)

forced to sell out to a larger company and it became evident that, while the system was suitable for special short lines, such as one operated near London, it was not practicable for considerable lengths of railway.

Armed with all the literature on the atmospheric railroads, Mitchell and the naval engineers set to work to perfect a more effective valve. They solved the problem by using a flexible steel sealing strip which runs the full length of the cylinder and which is raised and pressed down again by an ingenious mechanism linked to the piston and the arm.

Figure 1 shows an aircraft secured by the towing bridle to the shuttle; and anchored by a "hold-back" hooked to a fitting on the deck. When about to be launched, the aircraft has its engines running at full power. Steam is admitted to the cylinder and the combined power is sufficient to break a calibrated link in the hold-back. The aircraft then moves forward with an acceleration which has led to this type of launch being known as the "hot-ride."

Figure 2 shows a cross-section through the catapult and illustrates how the two power cylinders are installed side by side in the trough formed in the flight deck. This trough is closed by two portable tracks or portions of deck which carry the channel-shaped rails in which the shuttle runs upon its rollers. The body of the shuttle is in the shape of an inverted "T" of which an upper part projects through a slot between the two channel rails above the deck and forms the hook to which the towing bridle is attached. The flange of the "T" on the underside is furnished at each edge with projections or "dogs" which engage corresponding dogs in the driving key attached to the piston.

One of the features which made it possible to apply the principle for ship service was that the cylinder cover and the sealing strip are so devised as to restore to the cylinder the strength which is lost by reason of the slot in it.

Before the system could be adopted, however, a method had to be devised for stopping the piston and shuttle from shooting

(*Continued on page* 36)

with ARC's NEW CD-1 Course Director

Now there's no need to sweat out ILS approaches or fight to maintain OMNI tracks! ARC's new Course Director automatically directs the pilot to the correct headings required for effectively intercepting and making good a desired track. Heart of the system, the Compass Slaved Directional Gyro, gives constantly corrected directional information. System is accurate to one degree.

Computer portion of the system combines directional and track information obtained from the Localizer/OMNI Receiver and makes computations to provide the pilot with correct heading to intercept and/or make good a desired track, compensates for cross-wind. It relieves the pilot of 90% of his mental effort, prevents missed ILS approaches, saves time, effort and fuel, assures greater safety. Ask your dealer for complete information.

Dependable Airborne Electronic Equipment Since 1928

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Omni Receivers • 900-2100 Mc Signal Generators • UHF and VHF Receivers and Transmitters • 8-Watt Audio Amplifiers • 10-Channel Isolation Amplifiers • LF Receivers and Loop Direction Finders

Special Boston ATC Regs Announced Aero Comm.

The Commonwealth of Massachusetts Aeronautics Commission has announced a set of regulations governing *specifically aircraft intending to land at or take-off from* either Logan or Bedford Airports.

Basically, an ATC clearance is required prior to entering a 5-mile radius *for the purpose of landing;* and two-way radio and control is required for either airport.

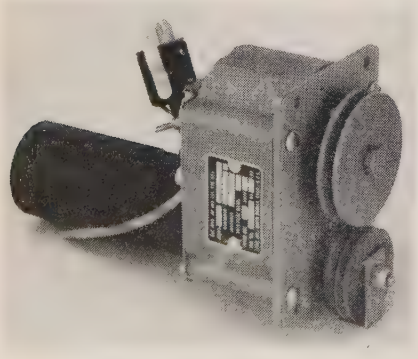
Slightly different from general practice but not unlike the 1200′ pattern altitude rule in effect at New York airport, is the following pattern entrance requirements:

a. Aircraft having a gross weight of over 12,500 lbs enter at 1600′ msl, or 1500′ above field level.

b. Aircraft having a gross weight of less than 12,500 lbs enter at 1100′ msl, or 1,000′ above field level.

For the purpose of interpretation the 5-mile radius could reach to any altitude, but inasmuch as these local rules ostensibly apply only to aircraft *using* these airports, it would appear that aircraft passing through the area VFR without intent of landing, should be relieved of both those requirements and CAR 60 requirements by maintaining at least 1,000′ above the higher specified pattern altitude.

If weather and/or cloud base precluded the foregoing, it would appear to be advisable to check in and obtain either ATC clearance and/or traffic protection.



LEAR *Pitch Trim*

Electric Pitch Trim Offered by Lear, Inc

One of the more bothersome chores of instrument take-off or approach, or during the same maneuvers in rough air has been the continual requirement to retrim the aircraft. The need to spare a hand from either the wheel or throttle quadrant may now be eliminated by introduction of a motor-driven elevator trim tab.

Usable on either single or multi-engine aircraft, it mounts in the manual elevator trim-tab control system, and is operated by a fingertip switch on the control wheel. The plane is automatically trimmed, nose up or down, merely by thumbing the switch up or down. The desired trim attitude of the plane remains fixed when the switch is released.

Lear points out that development flight tests of this unit revealed it to be extremely valuable as a piloting assist device. This was dramatically illustrated during take-off and in making approaches under instrument conditions at which time the pilot's hands were well occupied with many duties equally as vital as keeping the plane in proper trim.

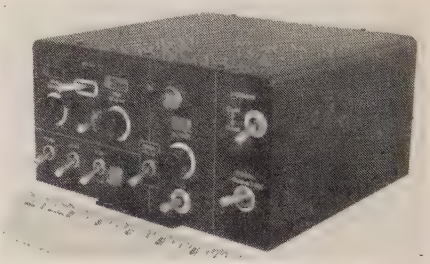
The Model 868-4 Series, which weighs only 3½ lbs, is available for either 12- or 24-volt electrical systems. It can be installed in a short time by any licensed A&E mechanic.

Automatic Sextant Long Range Over Weather Flight

An experimental model of the first automatic sextant in the history of aerial navigation has been designed and developed by Kollsman engineers, according to an announcement by Victor E. Carbonara, president of Kollsman Instrument Corporation.

"The first version of the new Kollsman Photoelectric Sextant," Mr. Carbonara said, "will give us information necessary for the development of production models. Recent tests on the protype have been successful and indicate that the instrument will save time for the navigator, simplify his job, and reduce the possibility of human error."

"The Kollsman Photoelectric Sextant," he continued, "automatically sights and tracks the sun during the day and the stars and planets at night. Manual sighting of celestial bodies will not be necessary and *the new sextant will retain its sight on a star and continue to track it automatically during and after changes in course.*"



KOLLSMAN *Photoelectric Sextant*

Also, with the new Kollsman instrument, flexibility of installation will be greatly increased.

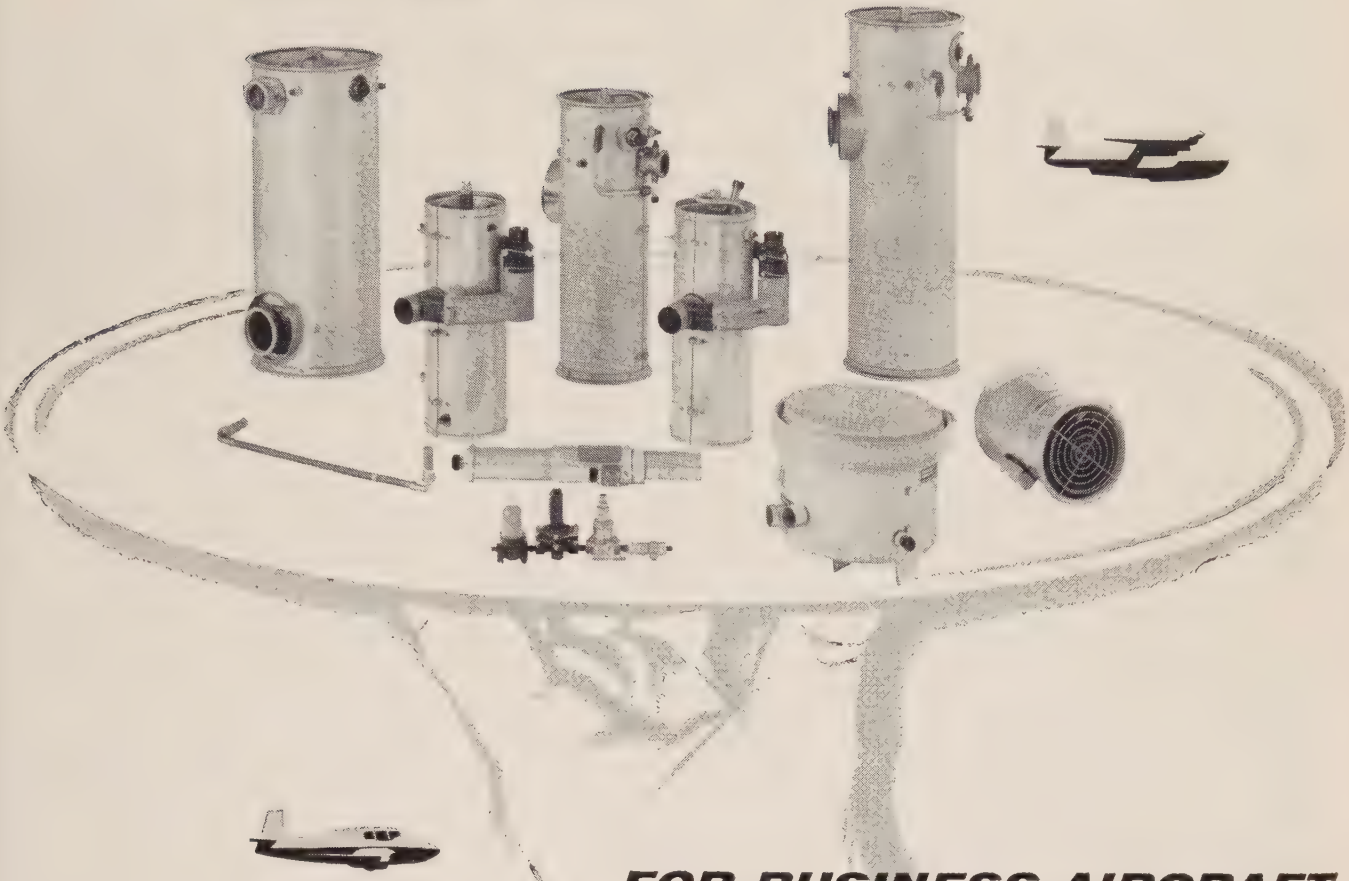
The combination of automatic operation and remote control is the key to the many advantages the Kollsman Photoelectric Sextant has over previous aerial navigation instruments. The navigator will read information directly from a remote indicating panel which is readily accessible to him. The remote panel contains all controls necessary for operation of the Photoelectric Sextant and is the only part of the instrument to which the navigator must have access. It is this remote indicating feature that gives the Photoelectric Sextant its greater field of observation. As the sextant tracking device need not be near the navigator, it can be installed in any section of the aircraft where it has an unobstructed view of the sky.

There are three components in the Kollsman Photoelectric Sextant: the sextant tracking device, the indicator with the control panel, and the amplifier. Operation is simple. The navigator pre-sets on the control panel the estimated position of the selected celestial body. Automatic operation then takes over. The sextant tracking device, which has a photosensitive telescope, searches for the star from which readings are to be taken. The telescope sweeps from right to left with several steps of elevation, searching a patch of sky 7° wide by 5° high until it automatically recognized the star to be tracked.

As soon as the star is recognized, the system starts its tracking operation. During this phase, an illuminated "T" is visible on the indicator. An automatic averaging period can be started at any time by throwing a toggle switch. When the averaging period is over, an "R" lights up on the panel, indicating that the navigator "reads" the average star altitude.

(*Continued on page* 30)

COMING RIGHT UP



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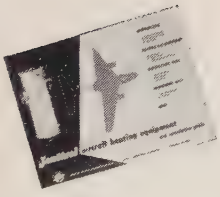

New 58-page catalog—for business aircraft owners and modification centers—showing all Janitrol models, accessories, components—installation tips, and engineering data. Please ask for Catalog No. 100.

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(*Continued from page 28*)

Because the Photoelectric Sextant automatically will retain a star when the aircraft changes course, repeat observations can be made with the same star or the sun, a valuable asset for final determination of true heading. Whenever a celestial body is tracked in level flight, the system will measure accurate relative bearing. This information can be used by the navigator to determine true heading or star azimuth.

The star telescope's photoelectric scanning system is designed so that aurora phenomena, haze or moonlight have no effect on its function.

The Kollsman Photoelectric Sextant will fill a need that has been increasingly felt since the introduction of high-speed, long-range aircraft, the backbone of the nation's Strategic Air Command. Very limited space and cumbersome pressure suits make it difficult for crew members to move about during flight. The remote control of the Photoelectric Sextant enables the navigator to operate the sextant without leaving his station. He need not even stand up.

As with every other military development, its effect eventually will be felt in civil aviation, especially in commercial overseas operations and commercial airborne applications over foreign areas not as well equipped for radio navigation as the continental U. S.

Another advantage of the remote control factor is that it eliminates the serious problems of installation encountered with other types of sextants for which a transparent canopy must be pierced to accommodate the mount.

Tests show that under normal flight conditions, accuracy within two miles can be obtained with a running fix from a succession of several star shots.

Air-Aids Spotlight

ALBUQUERQUE, N. Mex.—*ADF beacon at BELEN on south course now on 206 kc.*

CHARLESTON, W. Va.—*ILS Outer Locator changed again, now on 303 kc.*

ELKINS, W. Va.—*LFRange frequency now 245 kc, old CHW LOM frequency.*

FT. WORTH, Tex.—*MEACHAN Field ILS inoperative indefinitely.*

LOS ANGELES, Cal.—*VAR finally replaced by BVOR on 113.6 mc between field and DEL REY FM.*

PACHUCA, Mex.—*New VOR being installed about 50 s mi NNE MEXICO CITY.*

RICHMOND, VA.—*New CHARLES CITY FM (–) located approx 20 s mi out on southeast course.*

ROANOKE, Va.—*New TVOR located on airport due commission this month.*

SAN JUAN, P. R.—*New ADF beacon on 326 kc located about 3 s mi south of ISLA GRANDE airport and about 5.5 mi WSW of INT'L Airport.*

TETERBORO, N. J.—*New ILS Middle Compass Locator on 203 kc "EB".*

TORONTO, Ont.—*ILS Localizer serving Runway 5 indentification changed to "TZ" on 109.5 mc, and identification of LOM now "T" on 266 kc.*

TRENTON, N. J.—*MERCER COUNTY Airport installing private TVOR.*

WILMINGTON, Del. — *ILS Outer Compass Locator now on 251 kc.*

CAB Reports Findings on Corporate Copter Crash

(*Ed. note:* Because of the increasing interest in the use of the helicopter as a business or working anrcraft in many fields, NAVICOM feels that the following report, carefully abridged from the official CAB report, is of vital interest to all business-aircraft operators. It is offered without comment.)

The Accident

A Sikorsky helicopter, model S-55, N 737A, owned and operated by ———— Helicopters, Inc., crashed offshore in the Gulf of Mexico near Grand Isle, La., December 2, 1954. The accident occurred during an attempt to land in heavy fog. Four of the five passengers perished, one passenger and the crew of two received minor injuries. The aircraft was demolished by impact and fire that followed.

History of the Flight

N 737A departed the Grand Isle heliport at 0115 for the purpose of transporting oil drilling employees between Grand Isle and an oil drilling rig located approximately 6 miles offshore. After reaching the drilling rig, designated ST-6, a normal landing was made on a helicopter landing platform constructed on the deck of an LST anchored adjacent to the drilling rig. At 0218 the flight departed for the Grand Isle heliport, a flight which normally required approximately 10 minutes. At departure, lights located on other offshore rigs and on shore, varying between 6 and 10 miles away, were clearly visible but with a slight halo attributed to haze.

As the flight proceeded toward the shore vertical visibility steadily and rapidly decreased. Shore lights, dimly visible, were recognized and the flight turned right following the shoreline eastward toward the heliport. After reaching the landing area, the hanger lights and a continuously burning oil residue flare, also located near the heliport, were visible only as a glow through the fog from an altitude of 500 to 600 feet. A letdown was started but during the descent visibility became worse and visual reference with the lights was lost. A pull-up was then executed to about 450 feet, which was the top of the fog layer.

An attempt to land on an unobstructed clearing near the hangar was abandoned when the hangar lights could no longer be seen and a second pull-up was made. At this time the pilot could no longer see lights in the area of the various offshore rigs. At 0232, immediately after this pull-up, the fuel warning light came on indicating 30 minutes of remaining fuel. The pilot then decided to land on the clearing near the flare by approaching the flare from the east and using it as a ground reference through the fog. A descent was started toward the flare with approximately 40 knots forward speed. The approach seemed normal until the pilot realized he was overshooting the flare. At this time considerable glare was reflected in the cockpit. Noting an exaggerated nose-down but laterally level attitude on the pilot's gyro horizon instrument, full power was applied. The altimeter was then indicating about 250 feet. Only a few seconds thereafter the aircraft struck the water.

Both crew members and one pas-

senger were able to extricate themselves from the wreckage before fire started and spread to gasoline and oil on the surface of the water. Fire prevented them from approaching the wreckage to help the others and they swam to shore, guided by a light dimly visible through the fog.

Investigation

Most of the wreckage of the helicopter was recovered. Examination revealed that at the time of impact the aircraft was nearly level and was descending toward the water at an angle of approximately 35°. Impact forces were severe in an upward and rearward direction. The fuselage was moderately telescoped and was broken off at the rear of the passenger cabin. As a result of impact, wave action, and salvage operations the cabin and cockpit areas were nearly destroyed above the level of the passenger cabin floor. There was no evidence found of structural failure or fire damage prior to impact. Although the weight and balance manifests aboard the aircraft were lost, load computation and the seating arrangement indicated that the aircraft was loaded to a gross weight well under the maximum allowable of 7200 pounds and that the load was properly distributed in relation to the center of gravity of the aircraft.

At the time of the accident the flying operation of ———— Helicopters, Inc., was varied and extensive in the United States, Panama, and South America. In the Grand Isle area it was confined to transporting oil and oil-well drilling company personnel very short distances between Grand Isle and offshore drilling locations, providing a fast and comfortable means of transportation on a regular and emergency basis, involving approximately 45 flights during a 24-hour period.

Investigation disclosed that the company standards for pilots were high and that training and supervision were continually conducted to insure a safe operation. Company policy gave the pilot authority to discontinue or cancel a flight if conditions, in his opinion, made the flight inadvisable. The minimum weather condition for VFR flights was established as ceiling 300 feet and visibility ½ mile. Other operating procedures and requirements provided that passengers be equipped with and wear life jackets and take seats commensurate with the best loading pattern. The copilot also prepared required manifests and ascertained that seat belts were fastened before the flight.

The Company's operation required that the helicopters have sufficient fuel for the next scheduled round-trip flight in addition to a minimum of 30 minutes reserve fuel. Investigation revealed that the aircraft was so refueled prior to the subject flight.

Several witnesses substantiated the crew's statements that prior to the time of take-off they could see shore lights and other offshore drilling rig lights which varied between 6 and 10 miles away. Stars were clearly visible. Witnesses offshore and at the heliport stated that at both locations fog formed very quickly soon after the flight departed.

Both crew members were First Pilots and well qualified and had received regular checks on company operating and emergency procedures. As a safety measure at night two pilots were required and traded the flight commander's position every other flight. Communications equipment installed in the aircraft, at the Grand Isle heliport, and at each offshore terminal provided continuous contact between the aircraft and any terminal on one fixed radio frequency.

At the present time helicopter flight characteristics have made instrument flight difficult under certain conditions, especially during the approach and landing configurations where low speeds are necessary. Although great progress has been made, the S-55 helicopter and others have not been certificated as yet for commercial instrument operations. Therefore ———— Helicopters did not intend that flights be made unless continuous visual ground reference could be maintained.

The weather conditions which existed at the time of the accident consisted of a cold front moving slowly south until at 0030 on December 2 it was about 50 or 60 miles north of Grand Isle. The front separated a relatively dry polar marine air mass to the north and a moist tropical stable air mass to the south. Characteristic of the season, the inland water was colder than the Gulf water and night radiation cooled the land surfaces rapidly. As a result, the air near the surface was cooled to the dewpoint, whereas less cooling occurred in the Gulf water. These factors, coupled with the stable air mass and light surface wind, produced fog along the land and the inland and coastal waters in the Grand Isle area ahead of the front.

Investigation disclosed that ———— Helicopters had no arrangements for obtaining *aviation* forecasts or advisories for their operation, nor were there any official weather observations available to them for the immediate Grand Isle area. The Humble Oil Co., however, had a contract with a commercial weather service located in New Orleans for obtaining *marine* weather information and forecasts twice daily, at 0630 and 1530. These advisories and forecasts were received by telephone and immediately made available to the helicopter company, and were posted in flight operations for the pilots. The commercial weather service also provided special weather information when they considered it pertinent.

(*Editor's note*)

The crew stated that they read the weather bulletins and because of the forecast they were especially observant of the haze condition prior to take-off.

Analysis

It appears that the fog at Grand Isle formed in a light degree before the flight left ST-6 and that denser fog formed and moved in very rapidly during the flight. This situation and the accident that resulted showed the need for more frequent, more adequate, and detailed weather forecasts and advisories.

(———— Helicopters has ordered meteorological equipment to provide some on-the-spot weather information in the Grand Isle area and especially aid in determination of conditions under which fog may result. The company also will obtain radio equipment so that it may receive CAA aviation weather broadcasts from New Orleans, which will be utilized in their offshore operations. They will install a TWX circuit from Lafayette for receiving forecasts and other information from CAA schedule "A" circuit.)

Upon reaching the Grand Isle landing area, the crew found it covered by ground fog. The situation, therefore, was an emergency for the crew. Additionally, remaining fuel, although adequate for the company's normal operation, was insufficient for an extensive continuation of the flight. It is believed that in the emergency the crew should have called ST-6 by radio to make a positive determination as to whether or not the fog was existent there also. However, evidence indicates that shortly after departure fog did reach that position and within the time required to make the return flight it would have been fog bound.

During the pilot's attempt to make a visual landing near the oil flare, it is believed that he began to lose visual reference with respect to the attitude and position of the aircraft during the descent into the fog. As the aircraft passed over and beyond the flare, the condition was aggravated by reflected glare and immediate darkness which followed. At this mo-

ment. without visual reference the pilot lost control of the aircraft.

Findings

On the basis of all available evidence the Board finds that:—The aircraft and crew were properly and currently certificated. The aircraft was loaded to a weight well below the maximum allowable and the load was properly distributed. At departure from ST-6 lights were visible between 6 and 10 miles away but with haze which had existed during the entire evening operation. During the flight, fog developed rapidly over the area from the surface to about 450 feet above the surface. The S-55 type helicopter has not been approved for instrument flight. Lack of weather equipment prevented timely anticipation of the fog. There was no power or structural failure or other malfunction of the aircraft prior to impact.

Probable Cause

The Board determines that the probable cause of this accident was the loss of visual reference caused by fog and glare, which resulted in a loss of control by the pilot during an attempt to land.

By The Civil Aeronautics Board:

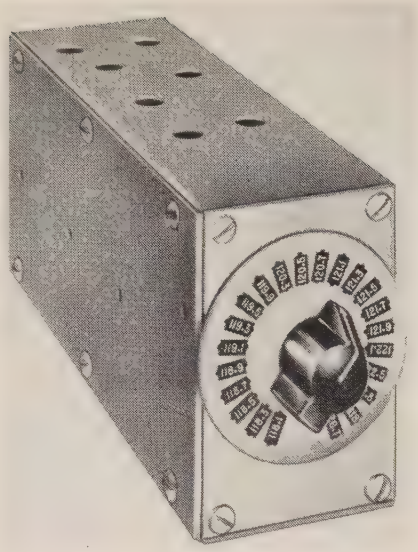
New 22-Channel VHF Aircraft Transmitter

One of the continuing annoyances of new aircraft delivery practices is the lack of adequate radio facilities within the quoted price. Manufacturers make the point that the customer will want to select his own combination and so in most cases offer an inadequate set-up as a part of the whole purchase.

To meet this situation, there has come on the market a good deal of what should be called supplementary radio equipment, designed to be added to already installed equipment in order to meet the increasing demands for multi-frequencies and dual navigational equipment. In truth, a complete radio combination actually could be built up from just the supplementary equipment plus an independent power supply.

One of the latest and finest such rigs is the new Dare 22-channel VHF transmitter, a companion piece to the line of aircraft radio produced by Dayton Aviation Radio and Equipment Corp. of Troy, Ohio.

The new transmitter may be employed on any VHF channel from 118.0 to 127.0 mc. A uniform power output of 3 to 4 watts is provided on any channel within the range. This uniformity is provided by a unique



DARE 22—*Channel VHF Transmitter*

condenser tuning system, in which rotation of the channel selector switch also rotates a ganged segmented condenser, providing precise peaking for three tuned circuits. Each segment of the condenser rotor is employed on three channels, with a frequency spacing of up to 2 mc for each group of channels.

Crystal-controlled oscillators, plus temperature-compensated components and precise tunng adjustments result in a frequency stability of .01% or better on all crystal channels.

Two transmitters may be connected to a single power supply, with staggered frequency selection to provide up to 44-channels for regular or emergency operation.

Measuring only 2½ x 3½ x 7¾ inches, the transmitter weighs 1.6 lbs. It is available with either local or electrically operated remote channel selection. The transmitter may be installed in a common escutcheon with its companion receiver, and is available for either 14- or 28- volt systems.

New ADF Meets Latest ARINC Requirements

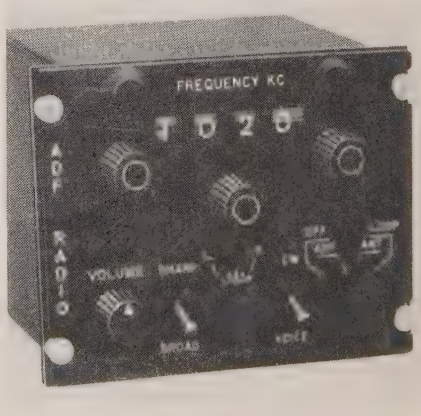
In line with the policy of never standing still or resting on the laurels of past successes in its field, the Lear Cal Division of Lear, Inc; Santa Monica, Calif., has announced another new ADF based on the latest ARINC standards for this type equipment.

The new Model ADF-16 provides the pilot with complete electrical remote-control system. The remote-control unit is extremely compact. Note the combination power "On-Off" and function switch. Also clearly indicated are the tuning control and frequency indicator, the left or right loop rotation speed control, the sharp or broad-band selectivity switch, volume control, and "CW-Voice" switch. Edgelighting illuminates position of all controls as well as control markings. Panel width is 5¾, height 4½, 4" deep and weighs less than three pounds.

Any one of an infinite number of channels within the frequency range of 90-1750 kcs may be accurately selected within three seconds. The remote tuning control utilizes two decade switches for selection of channels at 100 and 10 kc intervals and, combined with a variable fine tuning adjustment having a spread of 10 kcs, provides continuous tuning. Precision tuning is accomplished by means of selection of crystal-concontrolled oscillator circuits. The remote control units provide counter-type direct reading of frequencies in kilocycles and fifths, accurate within .5 kcs and with excellent readability. Band switching is accomplished automatically inside the receiver with the selection of an operating frequency.

The ADF-16 receiver unit is contained within a ½ ATR rack size package; standard plug connectors and shockmounting are used. Total weight is about 25 lbs. Adequate servicing adjustments with locking controls are provided to facilitate maintenance, and are readily accessible from front and sides of the receiver simply by the removal of the front cover plate or the removal of the enclosure. The receiver may be equipped with a blower for forced air cooling.

Environmental specifications permit the normal operation of the ADF-16 under conditions of an ambient temperature variation of —55 degrees to 70 degrees centigrade, humidity changes from 10%-95% at 50 degrees centigrade, and at altitudes from sea level up to the equivalent of 30,000 feet without pressurization. Under extreme ambient temperature conditions ranging down to —40 degrees centigrade, the tuning accuracy does not deviate by more than 3 kcs.



LEAR *ADF-16*

LEAR *NAFLI*

Lear Announces "Natural Flight" Attitude Indicator

It seems that instrument designers, especially those employed by Bill Lear, never sleep nights but spend the time figuring ways and means to further narrow the sensor margin between visual and instrument flight. A whole generation of pilots has ground up in the tradition of learning to interpret airplane attitude in terms of a simulated horizon, whether it be a simple lubber line moving behind a mock airplane or an earth-sky divided sphere.

The latest trend in instrumentation being towards factual pictorial indications, it is not surprising to find that Lear has substituted a little airplane (actually two) that dives and rolls in space almost as if the pilot were flying formation with himself and observing visually. Lear calls the instrument the NAFLI, meaning Natural Flight Instrument System.

It combines in a single 3-inch display all the data previously presented by the conventional directional and attitude gyros and, Lear claims, in a more simplified natural form. Attitude of the plane is indicated by pointers actually shaped to portray an aircraft silhouette as seen in profile. The *pitch* pointer shows the airplane's attitude as viewed from abeam the right wing tip. The *roll* pointer shows the airplane's attitude as viewed from a position behind the tail! It is claimed that such profile-type display results in considerably less pilot reaction time.

The addition of directional information reduces the pilot's cross-check problem and makes precision instrument turning much easier. For example, to turn to a desired heading, the airplane is banked to the selected bank angle until the desired new heading is read on the compass card directly under the roll pointer. The turn is completed by decreasing the bank as necessary to hold the roll pointer and new heading indication superimposed. Bank becomes zero as the new heading is assumed, *resulting in a precisely completed instrument turn,* even for the novice. Pitch attitude can be controlled in the turn without reference to any other instrument.

All three indicators are contained in one 3⅛ inch standard case. The synchros in the instrument receive signals derived from the directional and vertical gyros installed in a remote NAFLI amplifier chassis. The directional gyro can either be slaved to the earth's magnetic field or be operated as a free gyro at the option of the pilot. In the latter case, the low drift rate of the directional gyro, together with the latitude compensation provided for the earth's rotation, permits accurate navigation in the polar regions.

The precision gyroscopes used in the NAFLI System are intended to serve as a basis for an autopilot which may be installed at a later date. Synchro connections are available for this purpose. Thus, duplication of cost and weight of these instruments is avoided.

The NAFLI is designed to conform to MIL environmental specifications. The gyroscopes and associated electronic equipment used in the system fit in a ½ ATR mounting base. Transister amplifiers are employed to insured maximum ruggedness and reliability. Weight of the complete system is approximately 27 pounds.

By-products of the NAFLI systems beyond purely instrument simplification will be reflected in the cutting-down of many hours of costly instrument-training time generally required of conventional systems.

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Curious?

MOODBEAMS #7

Being curious about a fizzing firecracker is comparable, say, to NOT being curious about the condition of metal fuel tanks in an airplane. On the one hand, Hope Frarer (24, 5′ 5″, 118 lbs., blue eyes, blonde hair) may get the lipstick blasted right off that pretty, perky face of hers.

On the other hand, a pilot with a leaky gas tank may — well-llllll, you know!

If you aren't sure about your tanks, we urge you to get curious NOW, and let us remove, clean, inspect, and repair them; slush them with a protective compound, and reinstall them in apple-pie order. In any event, this should be done every thousand hours or two years.

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TRI-STATE COLLEGE
875 College St., Angola, Indiana

Skyways Round Table

(*Continued from page 17*)

X-band."

Rolland S. Mangel: "I believe that with a sandwich dome you get an average of at least 5% more transmissivity that with the thin-wall dome."

Bert Rashkow: *"How can transmissivity be improved by employing a double-wall dome rather than a single wall?"*

George Church: "It's strictly a matter of mechanics. If you had no strength problem, you could use a very thin layer of single-thickness material and have very low transmissivity. The problem, however, is can you make a solid single layer thick enough to withstand the conditions imposed, or would it be better to use less total material by employing one very thin layer of Fibreglas, than a honeycomb, and then another thin layer of Fibreglas? You have more strength for the same amount of material in a honeycomb sandwich device and, therefore, you have less total material.

"You make the two walls the proper fraction of a wavelength apart so that the reflections from one are canceled by the reflection from the other, and the net effect is an improvement in transmissivity."

Bert Rashkow: *"Wouldn't that be more easily achieved with X-band than at C-band because of the lower frequency?"*

George Church: "You can't have an ideal situation for both in the sandwich material, but you can have a situation that is entirely adequate at both frequencies."

Rolland S. Mangel: "That's the situation that exists right now with the Douglas dome."

Bert Rashkow: *"That's an interesting point to be considered by those who don't know which way to jump . . . to C-band or X-band.*

"In the case of the antenna installation, I believe you have the option of either mounting the antenna with the dish hung from above or supported from below. Is there a preferred method of mounting either the RCA or the Bendix antennas?"

George Church: "It makes no difference with the Bendix. It's purely a matter of convenience. When you do install it upside down, you must make certain wiring changes so that your tilt and stabilization systems don't get confused."

Rolland S. Mangel: "That same thing applies in the case of the RCA. The changes George mentioned are only so your stabilization works for you, and not against you."

Gene Baker: "With the DC-3, I think it would be more convenient to mount the antenna so that it is supported from below, so the waveguide can be brought up from the underside of the aircraft, below the cockpit floor.

"With the *Lodestar*, the contour dictated that the antenna be supported from above.

"Conceivably, someone in the future could give us a radome that would permit you to mount the antenna either from above or below. Mounting it from above introduces the problem of waveguide routing, and with the DC-3 you run into the problem of instrument panel interference."

Bert Rashkow: *"How are we assured of the fact that in mounting the antenna we obtain transmission of the radar signal parallel to the line-of-flight of the aircraft? Do you have to use a very precise method of leveling the airplane and then mounting the antenna so that you are certain that when the airplane is in flight you have the transmissional signal at zero degrees when the tilt control indicator says zero degrees?"*

Don Ladd: "The antenna mount is attached to a station which is perpendicular to level flight and the vertical gyro is mounted to be level in flight position. There are adjustments that can be made on the antenna for azimuth zeroing or tilt zeroing, and it is stabilized by the gyro system."

Bert Rashkow: *"If you make adjustments on the antenna, possibly because the rotation axis of the antenna is out of perpendicular with the aircraft line-of-flight, does that bring up a problem relative to the amount of stabilization that you can get? For example, we have plus or minus 15° limits of stabilization. Now, do we deprive ourselves of any angle of stabilization near the limits of that angle? Let's say we have 3° and we compensate, do we bite off 3° of our stabilization limits?"*

George Church: "You should have the axis of the gyro and the axis of the antenna mounted on the same plane. This gives you full range with no problems. If you do this, your antenna may be looking slightly up or down when set at zero tilt. If you were to displace your gyro by the same amount, then you would have perfectly accurate stabilization.

"The tilt angles on the antenna are really plus and minus 20°, but they go beyond that. I'm speaking now of the Bendix."

Rolland S. Mangel: "RCA goes to plus 32° and minus 35° total excursion. That is not just tilt, but is total excursion which is tilt, plus roll, plus pitch."

George Church: "By rights, your antenna should be perpendicular to your normal line of flight. How far you can deviate from that is not important, except that the limits of stabilization are slightly reduced. You should, however, have the rear mounting plate or whatever you use for zero tilt reference on your antenna, aligned with your gyro."

Bert Rashkow: *"Then, if that isn't accomplished, the zero degrees on the tilt indicator do not mean zero degrees; in other words, it doesn't give you a straight-ahead indication on the scope. You may be looking a little down or up, depending on which way it is displaced."*

George Church: "That's right. For example, you might be looking too high dead-ahead or too low when the antenna points to the rear."

Rolland S. Mangel: "Actually, the only place that could get you into trouble would be if you were using the safety circle technique for terrain avoidance and cutting it very close, too close for good practice."

Bert Rashkow: *". . . all of which brings up the question, how do we stabilize? As far as I know, both Bendix and RCA equipment are compatible with the Sperry gyro system."*

Don Ladd: "With both the Sperry and the Pioneer systems. In our installation on

the Forrest Oil plane, we used the Sperry vertical gyro. They did not have a Zero Reader or an A-12 installation.

"When using the Sperry gyro, it is necessary to construct a power supply erection circuit to feed the gyro."

Bert Rashkow: *"Is that designed to cause quicker action?"*

Don Ladd: "Yes, the Sperry gyro slow erection is approximately 5° per minute and the fast erection is about 30° per minute."

Gene Baker: "Something I haven't previously mentioned to Don is that we recently found it wasn't absolutely necessary to use the fast-erection circuitry. In cooperation with Sperry we found that the slow erection is sufficient when using the gyro solely for stabilizing the radar antenna. This will simplify the additional circuitry.

"Incidentally, we are coming out with a smaller gyro designed specifically for antenna stabilization and it will be available soon."

Bert Rashkow: *"Couldn't you use some of the older type panel-mounted gyro horizons with pitch and roll axis Autosyns installed for that purpose?"*

George Church: "Due to the way they are connected internally, most of them tend to have a fair amount of phase shift in their output voltage as against the amount of tilt voltage they generate. Also, they may have different sensitivities. We require an output of 50 millivolts per degree. That leads to a certain amount of uncertainty in performance, and so we prefer to use the new gyros."

Bert Rashkow: *"Cal, you're in the process of installing radar in a B-23. What with most of the radio mounted up in the nose of that airplane, aren't you having an even tougher problem?"*

Cal White: "The B-23 has an A-12, so that's the least of our problems. The nose-mounting of the B-23's radio equipment has made it necessary for us to extend the nose forward some 28 inches. In other words, the bulkhead which mounts the antenna is 28 inches ahead of where it was. That means there is no way to get to the radio equipment because you can't reach it from the cockpit.

"Previously, to get to the radio equipment, you unbuttoned the nose, similar to a DC-3, and by putting in an access hatch at the top of this 28-inch section, you'd have room to slide things in and out. But the two black boxes for the radar now have to go up there so there'll be about a 20-inch space between the aft end of the radar black boxes and the forward end of the radio equipment. As it turned out, however, the radar equipment is mounted to the right side, off center, which allows easy access to it and the radio equipment."

Gene Baker: "Cal, wasn't that extension primarily to make space for the radar units themselves?"

Cal White: "Originally, the nose was lined with junction boxes, and that meant we couldn't cut an access hole in either side, top or bottom. It was just a solid junction box built to fit the contour of the airplane. Rather than relocate all of the boxes, which would have been a major undertaking in itself, we built the extension. We could have put the radar units back in the cabin somewhere, but that would have meant a long plumbing job run for the waveguide. The owners of the B-23 seemed to consider the lengthening of the nose the lesser of two evils, so that's what we did. Actually, I think they like the looks of the airplane with the longer nose. It has turned out to be an excellent job and it works like a charm."

Bert Rashkow: *"The proximity of the transmitter-receiver to the antenna itself negates the matching problem you could get into, and hence the lesser the requirement for any sort of a matching stub in the waveguide.*

"Bob, could you give us an idea as to what the unit weight of the rigid waveguide is?"

R. W. Terry: "For unit lengths of aluminum and flexible sections, the flexible sections are the heaviest of the waveguide components, which is one reason why the amount of flexible waveguide should be kept to a minimum."

Bert Rashkow: *"How about the attenuation factor per foot in the rigid guide as compared to the flexible?"*

R. W. Terry: "As compared to standard C- and X-band waveguide performance, a double ridge guide is actually a compromise. The attenuation is somewhat less than a small X-band guide and greater than C-band. From the standpoint of power handling capacity, it has a higher power peak capacity than a standard small X guide and slightly less than C-band. However, its capacity in kw is many times the level used in the weather radars. So it is a compromise between the two standard waveguide sizes. Flexible waveguide is most any size, as far as attenuation is concerned, runs approximately 1½ to 2 times that of the associated rigid guide."

W. F. Palmer: "I'd like to take this opportunity to straighten out some ideas regarding safety or hazards involved in the antenna mounting in radomes. We have a magnesium casting on the RCA set and it's a known fact that magnesium is highly combustible in powder form. This is not the case with magnesium castings. I have examined several military radomes that have been severely damaged by lightning and there has never been a case where the antenna itself has been damaged or affected in any way.

"Weight, by the way, was the main reason we built the RCA antenna of magnesium."

Bert Rashkow: *"In such smaller type aircraft as the* Lodestar *and the DC-3, we have noticed a serious problem in the mounting of the indicator. In Page Airways'* Lodestar *installation and Remmert-Werner's DC-3, the indicators were mounted on the instrument panel. Cal, where are you going to put the indicator on the B-23?"*

Cal White: "The panel of the B-23 was reworked some two or three months ago and at that time they gave consideration to the mounting of a radar indicator, and left an opening for it. It isn't exactly the right size, but we'll make it."

Bert Rashkow: *"Would it be feasible to mount an indicator on the DC-3 on the slanting portion of the pedestal?"*

E. Desmond Kelley (*Director of Customer Maintenance, Reading Aviation Service*): "That is our thinking. The cross-section of the RCA indicator measures about 6⅛ inches; the Bendix is about 6 inches."

Bert Rashkow: *"Total width of the pedestal is about 6⅛ inches. You'd have to bend the carburetor air controls a little earlier than they are bent now, but you could mount either the RCA or the Bendix indicator right on the pedestal. Disadvantage might be that it would be inconvenient to have to reach back behind the throttles, etc., for the brilliance and focus controls and the range control. However, those controls are generally pre-set for a fairly long period of time, so it might not be such a disadvantage after all. You might possibly also have a daylight viewing problem because there is more of a tendency for light to fall on the face of the screen when it is faced up rather than being behind the glare shield near the top of the instrument panel. It might be pertinent to design some sort of a truncated hood with an angle filter to allow for light reflection."*

Cal White: "That is essentially the way we are installing the indicator in the B-23, except that it is further into the instrument panel . . . not more than an inch or two will protrude from the panel. The B-23 quadrant is not exactly like the DC-3's, and there will be some lever interference with true viewing of the scope. However, by putting it back further into the instrument panel, a hood can be put on to take away glare."

Bert Rashkow: *"There's an alternate possibility and, I believe, Bendix is using it in their plane, and that's to mount the indicator overhead so it can be swiveled either way. In the case of the DC-3, however, most of them have an escape hatch up there and the CAA regulation regarding that hatch must be complied with."*

George Church: "We have this escape hatch on our DC-3, so we built the indicator with a quick-disconnect feature. If the escape hatch is released, the indicator disconnects . . . and you lose an indicator along with the hatch."

Rolland S. Mangel: "Perhaps some sort of a stowaway indicator should be considered, one that plugs into your outlet or support bracket located some place between the pilot and copilot. That arrangement might permit a radar installation on an aircraft that might not otherwise be able to have one."

Bert Rashkow: *"TWA installed an indicator that way.*

"Going back to the problem of daytime viewing of a scope or the PPI, I understand a high-intensity or bright display tube is being developed."

George Church: "High-intensity tubes are available on an experimental basis now. They have not been fully tested as yet, but they are far enough along so that we can proceed with the engineering. Judging from present quotes, the price might be prohibitive."

Bert Rashkow: *"One of the final points has to do with mounting the radar controls. There have been arguments, pro and con,*

on mounting the controls on the instrument panel so they would be accessible to both pilot and copilot. In this case, however, both would have to reach to adjust the controls for tilt, gain, and range.

"Bendix is prepared to deliver the components themselves without the assembly for the control box. Is RCA planning to do the same thing?"

Rolland S. Mangel: "Yes, complete control panels will be furnished, but only upon specific request and according to custom specs."

Cal White: "Insofar as mounting the controls is concerned, the only problem would be to get the tilt, synchro indexed properly. Mechanically, there isn't much to it."

George Church: "Where you use a standard control panel, the entire system is indexed when it leaves the plant. But where you have to do something with the synchro, you're apt to upset it and then it would have to be re-indexed."

Bert Rashkow: *"For a moment, I'm going to take my Moderator's hat off and put on my Flight Safety hat.*

"In our capacity as engineering advisors, we are specifying an integral control panel for radar installations on three aircraft, specifications for which are now being written. We see no problem with either RCA or Bendix equipment in making an integral panel. What we do wonder about, however, is whether degree markings on the tilt control, to either left or right rather than up or down on the right side, would be more beneficial. This was proposed because it is difficult at times for the pilot to see the righthand degree engraving."

George Church: "Human Engineering is involved there. We went through a lot of trouble to have the pointer move up for uptilt, results: a better design before."

Bert Rashkow: *"Concerning tilt control, there is one other thing that must be remembered, and that is that these transmitter-receivers contain very strong magnets and we all know what they can do to instruments."*

Don Ladd: "Careful consideration must be given unit location in respect to aircraft instruments."

George Church: "These are permanent magnets and the condition exists whether the equipment is turned on or off."

Bert Rashkow: *"The waveguide servicing problem is perplexing and complex.*

"Bob, what basic inspection items should be noted and what can we do to make sure the waveguide is not a contributing element to poor performance?"

R. W. Terry: "You have to make sure the waveguide VSWR is within specifications and that the required minimum power is being transmitted. The simplest way of doing this is by reflectometer or bi-directional coupler method. Right now we are completing a double ridge guide bi-directional coupler and a small portable test box which will give an immediate indication of your VSWR power output."

Bert Rashkow: *"The bi-directional coupler is plugged into the system?"*

R. W. Terry: "It's inserted in the waveguide transmission line and may be replaced by a flexible section or left in the system, the latter being the more practical way of doing it. It has a negligible effect on system performance."

Bert Rashkow: *"If there is a question as to whether the antenna is performing properly, we can disconnect the antenna itself and insert a sand load or dummy antenna of some type to present space impedance."*

R. W. Terry: "The position of the antenna is going to have an effect on the VSWR measurements you make on the waveguide system due to the reflections from the radome itself. It may be small, but it will be noticeable upon antenna rotation."

Bert Rashkow: *"Such measurements, then, should be done out in the open in a clear, unobstructed position?"*

R. W. Terry: "Yes. I would think that minimum and consistent VSWR values would be observed with the antenna pointing dead ahead."

George Church: "It would depend on where the airplane happens to be. If you are on the average field and can't find a good place to look out into clear, open air, you might be better off turning around and looking back into your absorbing material. It isn't good, but it's dependable.

"If, however, you do have a clear, open area to look out into, you'd be better off pointing your antenna to that area and then make your adjustments. From then on you make such checks only to find out whether or not you've gotten dirt or water into the guide, or maybe put a dent in it.

"Normally, the guide won't give you any trouble. You might have some with the flex section because of the continuous flexing, but such a fault either exists or it doesn't. It isn't anything that gradually builds up on you."

Bert Rashkow: *"We've covered just about everything, gentlemen, and right now seems to be the time to summarize the discussion.*

"The installation of any of the currently available radar equipments poses a number of serious problems, all of which have a direct bearing on the subsequent maintenance costs of associated equipments and instruments in the proximity of the nose area, or on the operational utility of the radar. Because of the multi-faceted problems thus presented, i.e., antenna mounting and access, instrument access, control-panel design and location, indicator mounting, adequate AC and DC power supply, stabilization of the antenna, and magnetic compass errors due to magnetron magnet effect, it is necessary for the potential radar user to give serious thought to the antenna, radome, and equipment installation design.

"The method of AC utilization and resultant DC power drain on small aircraft gives rise to the necessity for an emergency DC power source to cope with the potential problem of failure of one generator, thereby possibly over-loading the second generator.

"Radome manufacture and installation so as to allow for adequate access to instruments is a problem for which solution is now becoming available.

"The mounting of instruments from the front side of the instrument panel all but precludes the use of 'eyebrow' lights. Hence, the glare-shield type of SAE lighting appears to offer an adequate solution.

"Stabilization of the antenna necessitates the installation of an attitude gyro unless a Zero Reader or an electronic autopilot is installed, in which case the associated attitude gyroscopes may be used.

"The weight of an airborne radar can approach 300 additional pounds unless efficient use of existing AC power is made and unless a thin-wall or honeycomb-type radome is used.

"Judging from the comments of the experienced participants at this Round Table, a radar installation cannot be handled with as much individual prerogative as, for example, a VHF transmitter-receiver installation. Instead, the individual installation design must be given intense study to arrive at an optimum of operational reliability, operational ease, maintenance simplicity for the radar itself as well as other affected components, and still realize minimum weight and low installation costs.

"Thank you, gentlemen, for giving us the benefit of your experience in the installation of radar."

Steam Catapult

(*Continued from page 27*)

onwards like a shell and out of the ship altogether. This is accomplished by a form of hydraulic buffer consisting of two steel cylinders, open at one end, into which water is pumped through a series of nozzles.

For the operation and control of the various valves and auxiliary equipment, a separate hydraulic system is employed wherein the pressure is generated by a turbo-driven hydraulic pump. This hydraulic power is used for retracting the pistons and shuttle from the forward end of the catapult after a launch to the after end ready for loading on another aircraft. This part of the equipment consists of a small hydraulic cylinder which, through a multiple reeving, propels a hook back and forward along the track, which hooks onto the shuttle at the forward end and draws it back to the firing position for release.

The controls of the catapult are centralized in a control console situated in the machinery compartment where the control worker operates all the functions of the catapult, the necessary indications and interlocks being provided electrically. A secondary control position is provided at the edge of the flight deck where a second control worker operates a push button which fires the catapult after it has been made ready at the main control console.

As a tailpiece, it can be stated that the latest advance in flight deck technique is an audible airspeed indicator known as Audio. In *SKYWAYS* of September 1954, there was a description of a visual airspeed indicator to be used in conjunction with the mirror sight. The sight gives the angle of approach; colored lights reflecting on the windshield give the speed of approach. These colored lights do not always show clearly, and so Britain's Admiralty has developed an audible instrument. It works on the principle of an electric organ and gives its assurance as to correct speed and warning of incorrect speed in the pilot's earphones as a background to the voice reception for which the earphones are primarily intended.

It so happened that one of the pilots engaged in assessing the new visual aid noticed that when the color on his windshield changed, there was a faint click in the earphones. It was caused electrically. This clue led to the development of Audio.

The apparatus is relatively simple, is accurate to within a quarter of a knot, and it is made in two separate parts, each of which fits into two boxes which can be placed in any convenient part of the aircraft.

Thus two of the most recent developments for Naval aircraft operations are the result of British perseverance and ingenuity.

Fuels and Oils

(*Continued from page 22*)

nation's fuel supplies were beefed up by this hot hydrogen process. High costs, until now, have kept the technique from general use in the U.S. Now, however, Socony claims that its new catalyst plus the oil-industrywide refinement of processes in which hydrogen has become plentifully available as a by-product of high-octane automobile fuel, have brought the process into commercial feasibility.)

Generally speaking, Socony has announced that "jet fuel produced by hydrocracking retains its stability for relatively long periods at temepratures in the range of 400° to 500° F." on top of that, the general announcement claims, the fuels so produced are extremely responsive to additives and with, for example, a new one developed by the company just for the purpose, the hydrocracked fuels "can be further improved for far greater stability than is believed to be required for supersonic aircraft." The process also would make such fuels as JP-5 more readily available.

In detail, however, the Socony research is more of an important signpost than a final answer.

Here is the way Socony's actual technical report on the research summed it up: "The thermal instability of jet fuels was shown to be related to the presence of trace amounts of reactive constituents. The hydrocarbons which make up the bulk of the fuel were found to possess excellent thermal stability.

"Since refinery treating processes are intended to remove reactive trace constituents, an unstable JP-5 fuel was treated by a variety of processes. In general, treating improved the high temperature stability of the fuel. Rather severe treating processes are required to make relatively unstable fuels acceptable.

Marked reduction in filter clogging characteristics was also obtained by the use of an additive developed for this purpose. However, it was observed that the additive tested was not effective in providing acceptable stability in some fuels. It was necessary to proide a minimum level of stability by treating and refining before the additive was effective.

Of particular interest in this investigation was the high level of fuel stability inherent in jet fuels provided by hydrocracking. This new process provides an attractive means of greatly increasing the yield of high quality jet fuels.

The major high temperature stability problem is one of filter clogging. However, a potential heat exchanger fouling problem also exists and should be investigated.

"Using available processes and additives, fuels can be produced which have far greater stability than has been indicated as being required. Full-scale engine test work is required to pinpoint the stability level required, and to provide a basis for correlating the laboratory test with the needs of the full-scale engine."

Way over on the credit side was a specific example of how the new process has increased the stability of an extremely poor quality straight-run JP-5 type fuel from a West Coast crude. The raw fuel had a running life of about 57 minutes before test filter clogging (as the fuel degenerated under bursts of jet heating) made it unusable. When the same fuel was subjected to sulphur dioxide extraction to remove *some* of the harmful components, the Socony paper states, "this fuel improved to 119 minutes." But, when hydrotreating was used, filter clogging time zoomed to an impressive 515 minutes, well beyond the minimum requirements suggested by engine manufacturers for the tests.

Making the announcement of the new fuel process was Donald P. Heath of Socony's Laboratories. Working closely with him on the research project were C. W. Hoffman and J. H. Reynolds.

A table of exact properties exhibited by the fuels from the Socony experiment is shown.

In the Southwest It's Dallas Aero Service

- AIRCRAFT
- ENGINES
- ACCESSORIES
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- RADIO

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Properties of Hydrocracked Jet Fuels

	JP-5		JP-4	
	Test Fuel	MIL-F-5624B	Test Fuel	MIL-F-5624B
Gravity, °API	45.6	35 min. 45 max.	51.5	45 min. 55 max.
ASTM Distillation, ° F.				
10% Evaporated	360	400 max.	205	
20% "	381		293	270 max.
50% "	416		363	370 "
90% "	499		428	470 "
End Point	521	550 max.	451	
Smoke Point, mm.	31	20 min.	28	
Smoke Volatility Index			59	54 min.
Aromatics, Vol. %	"	25 max.	6	25 max.
Olefins, Vol. %	1		1	—
Aniline-Gravity Product	7,240	4,500 min.	7,360	5,250 min.
Net Heat of Combustion BTU/lb.	18,700	18,300 min.	18,700	18,400 min.
Sulfur Wt. %	0.002	0.4 max.	0.002	0.4 max.
Freezing Point °F	—53	—40 max.	—76	—76 max.

now hear this . . .

James H. Chenet joined the aviation insurance department of Detroit Insurance Agency.

Raymond F. Hall was named assistant vice president of Eastern Division of Van Dusen Aircraft Supplies.

Mathias Klein has been appointed chief manufacturing engineer of Marquardt Aircraft Company.

Arthur C. Hartman has been named assistant plane manager of the Aircraft Products Division of Air Associates, Inc. **Walter B. Powell** was named general manager of Air Associates' Chicago branch.

Douglas F. Bush has been appointed Detroit sales manager of Airwork Atlantic's Detroit office.

HONORS

James H. Doolittle was selected by the Federation Aeronautique Internationale to receive the 1954 FAI Gold Medal. Presentation will be made in Paris.

M. E. Balzer, United Air Lines' meteorologist, and **R. J. Shafer** and **P. Funke** of Eastern Air Lines, were winners of the ATA's annual Edgar S. Gorrell Awards for research in meteorology and dispatching.

Capt. Lloyd D. Reinhard, pilot for American Airlines, was awarded an Air Force Scroll of Appreciation for his rescue of a lost jet fighter pilot over New Jersey.

COMPANIES

Dumont Aviation Associates have purchased Industrial Associates, Inc., and the entire operation has been moved to Dumont's Long Beach, Calif., facilities.

Weber Aircraft has been awarded an ejection seat contract for operational versions of the McDonnell F-101.

Pastushin Aviation has been awarded a contract for production of the forcible ejector-shackle mechanisms to equip Lockheed F-94C aircraft now in service.

Dayton Aircraft Products, Inc. is transferring all operations from Dayton, Ohio to Fort Lauderdale, Florida.

TEMCO Aircraft's prime overhaul contract to provide progressive heavy maintenance for Super Constellations has been extended by the U.S. Navy.

General Precision Laboratory, Inc., and **The Gonset Company** have become members of the Radio Technical Commission for Aeronautics.

AERO CALENDAR

July 2-6—Ninth Annual All-Women's Transcontinental Air Race. Long Beach, Calif. to Springfield, Mass.

Aug. 8-10—National Turbine-Power Air Transportation meeting, sponsored by IAS, Seattle.

Aug. 10-14—Air Force Association Convention, San Franscisco.

Aug. 15-20—National Flying Farmers Convention, East Lansing, Mich.

Aug. 24-26—Western Electronic Show and Convention, San Francisco.

Sept. 14—Airwork Engine Forum, sponsored by Pratt & Whitney and Bendix, Millville, N. J.

Oct. 5-7—National Business Aircraft Association Annual Meeting, Sheraton-Cadillac Hotel, Detroit.

All Weather Flying

(*Continued from page* 10)

April issues) be installed without delay at terminal airports. Each installation should include the condenser discharge lights of the type provided at Newark Airport.

The first safety requirement for visual aids—approach lights, threshold lights, stop way lights, runway lights or runway markings—is their simplicity of configuration without the need for pilot interpretation or the possbility of pilot confusion.

When I was first introduced to this subject of All Weather Flight in 1934, visual aids for landing seemed unimportant. There were some problems to be solved, but they appeared simple. It was then a generally accepted concept that airplanes would be landed completely blind in poor visibility conditions. In 1934, the biggest All Weather Flying problem of real significance was to determine by simulated flight test the relative merits of two different blind landing systems that had come into being. The National Bureau of Standards had developed one composed of a localizer and glide path. The cross pointer visual indicator was not too unlike our present ILS instrument. The frequencies used, however, were in the HF band between 2,000 and 6,000 kc. Both localizer and glide path were, consequently, affected by static interference. The flight path was curved; it was quite steep at an altitude of 1500 feet and gently flattened out at the threshold.

At Wright Field Capt. Hegenberger had come up with a different but simple blind landing system composed of two radio compass transmitters aligned with the airport. They were portable and could be set up in any direction for landing into the wind. The inner was located right at the edge of the landing area and the outer was five miles distant. A low glide angle was established by flying over the outer compass station at 1,000 feet, and the inner one at 50 feet. This glide angle then was continued down to ground contact. There were no runways to reckon with where this military system was used.

I was given the assignment of flight testing the two systems. These flight tests were conducted with the largest, fastest and most modern type of transport of that period, a Ford Trimotor, and they covered a period of several months at Newark Airport, Langley Field (Va.), and Patterson Field, Dayton. In all, 167 blind landings were made to a complete full stop.

On the Hegenberger system, an outbound course was established by first flying over the inner radio compass station, then returning to the outer one. This was done at cruising speed and 1,000 feet above sea level. A procedure turn was made by altering the outbound course 30° to leeward and continuing one minute before reversing to the approach heading.

At the outer radio compass station, the center engine was throttled to idling and the outboards to 1300 rpm each to give an approach speed of 70 mph and a 300-fpm rate of descent. This descent was continued to cross the inner radio compass station at 50 feet above sea level. If 50 feet was reached before crossing the radio compass station, the center engine was brought in to maintain level flight and 70 mph. Upon crossing the inner compass station, a 300-fpm descent was continued. However, at 25 feet the descent was checked but only by just a noticeable raising of the horizon bar by pulling back on the control column. After practice, this slight reduction in altitude near the ground made possible a comfortable landing technique.

The flight tests of these two systems eventually resulted in the radio compass stations being installed with the VHF localizer and glide path to give us the present ILS system.

It is interesting to note now in 1955 that the instruments on the Ford Trimotor in 1934 were not too unlike those of today's DC-6 and DC-7 airplanes. There was the large blue-background artificial horizon, the airspeed indicator, the rate of climb, the directional gyro, the altimeter, a radio compass needle and a cross pointer indicator. But there has been a big change in the concept of blind landings in the 21 years that have elapsed since 1934. Now, only the most visionary scientist could conceive of actually blind-landing a load of passengers in a DC-6B.

After those blind landing tests in 1934, an all-weather flying discussion panel such as this would have had few additional unsolved problems to talk about. However, as more weather flying became a matter of routine in the early '30's, more problems loomed up. Carburetors iced; communications and navigation radio became unusable in thunderstorm and precipitation static; wing loadings and approach speeds increased with each new type of airplane; and freezing rain and wing icing caused trouble, both on the ground and in flight.

As airline schedules grew in the latter 30's, so did the all-weather flying problems. There appeared during this period a monster that was soon to be king of all air troubles, namely, the control of air traffic. Whenever instrument approach weather moved into a busy terminal, airplanes would stack up at holding points faster than they could land. It was obvious that unless something was done to remedy this, air transportation would be limited. Therefore, during and immediately following World War II, everyone was hard at work on the traffic problem. Ideas and solutions ran rampant. During the height of this critical period, RTCA, representing all agencies, branches and interests of aviation, appointed a special committee, SC-31, to come up with components and plans to implement the common system of navigation, traffic control and landing. Subsequently, additional committees and boards have been selected or organized to work out the details and coordinate the many present-day complicated aspects of all-weather flight. For example, collision prevention at supersonic flight speeds is a tremendous thing that must be solved. Which elements of this solution will be in the cockpit and which on the ground? Shall TACAN replace VOR and DME for navigation? What about Console, Decca, Loran, Naviglobe, Teleran, or radar beacons?

What will be the trend of ground radar for overall traffic control; responder

beacons, digital autopilots, R Theta off-course computers, Veeder counters, lines of automatic communication, Volscan?

Where will the line be drawn on cockpit and instrument standardization, combining instrument indications, the use of flight directors, RMI and tumble-proof gyro instruments?

Other considerations are, the proper selection of airborne radar to avoid turbulence; the values assigned to reversible props, automatic power control, drag chutes, arresting gear, and, crash barriers; improvements and standardization of visual aids such as stroboscopic condenser discharge approach lights, Elfaka-type grid lights on stop-ways and runways; consideration of multiple thresholds; ILS reference point and market beacon locations; transmissometers; runway visual range; radar beacons and reflectors, infra red ray and radio altimeters; and the development of all-weather trainers and simulators to reproduce the psychological reaction to visual aids under minimum landable visibility.

The top-level group that is in a position to channel and screen these many factors of all-weather flying is the Air Navigation Development Board.

The Sperry All-Weather Flight Test Program has been right out in the thick of the elements for several years now, and we are fortunate to have R. P. Snodgrass, an engineer who has the pilot's perspective, with us on this panel.

All-Weather Flying Instrumentation

by Reuben P. Snodgrass

Engr. Dept. Head for Flight Research
Sperry Gyroscope Co.

Flying aircraft in weather has three general areas of concern: 1) icing, 2) turbulence, and 3) low visibility. Since it does not seem to be economically feasible to operate in weather regardless of the state of icing, turbulence or visibility, the problem is to define acceptable areas of operation. This involves the definition of intensity of the weather condition and determining whether it is within the acceptable operating range. If it is not, then the particular condition must be avoided. This results in either a trip cancellation or diversion to an alternate route and/or an alternate airport. It is this basic problem that has led to the constant demands for more and more accurate weather reporting. It might be interesting to note that, of the three general conditions—icing, turbulence, or low visibility, it is only the low-visibility phase of the weather which can be effectively changed. We cannot alter icing or turbulence, but we can alter the effective cockpit visibility through the use of high-intensity lights.

"All-Weather Instrumentation" has been primarily concerned with the low-visibility case. In the past 30 years there have been three broad avenues of advancement with respect to the instrument flight of aircraft. These are: 1) the development of means to control the attitude of the aircraft without visual reference being available to the pilot; 2) development of radio navigational aids; and 3) the development of visual aids on the airport.

The pilot's immediate task in flying an aircraft is to control the attitude of the aircraft. The major emphasis in the training of a pilot is directed towards teaching him to judge the proper attitudes for various maneuvers and to manipulate the controls accordingly. This requirement exists in visual as well as in instrument flight. It was not until the gyro was applied to the problem that instrument indications of attitude could be given to the pilot. The first milestone in this respect was the turn-and-bank indicator of the 1920's, and the second was the artificial horizon and directional gyro which were introduced in 1929. These instruments, developed by the Sperry Gyroscope Company, were used by Jimmy Doolittle, together with a sensitive altimeter and a radio system similar to our present ILS to make the first completely blind take-off and landing. The third milestone in the attitude indication problem was the introduction of the flight director in 1948, the Sperry Zero Reader. This instrument was unique in that it combined in computer form the directional, attitude and radio displacement signals to provide a simple and easy-to-follow attitude indication.

Automatic flight control had a much earlier beginning. In 1914, Lawrence Sperry applied a gyroscopic stablizer to an aircraft so that it could be flown hands off. This application of the gyroscope was for the purpose of providing stability. It is interesting to note that the cycle is being repeated today in the case of the helicopter. In the '30's the displacement type of pneumatic or hydraulic automatic pilot became operational. Electric autopilots became operational late in the war. These provided markedly superior performance and were capable of coupling the aircraft to radio navigational signals. This development culminated in the so-called "automatic approach."

Today there are available on the market various types of flight directors and automatic flight control equipments which can tightly couple the aircraft to ILS. It is a simple technical problem to define the coupling performance of a pilot-flight director system or an automatic flight-control system on the ILS. However, it is difficult to define quantitatively the operational advantages which can be derived through the use of such equipment. This is due to the fact that the present ILS approach cannot be completely accomplished utilizing *only* instrument flight. Today's approach, automatic or otherwise, requires a transition from instrument to manual vision flight followed by a visual landing. This is satisfactory as long as the transition from instrument to visual flight can be made readily and at a position in the approach zone from which a conservative final approach and landing can be made. The transition, as it exists today, is very undesirable from a psychological standpoint. Under low-weather conditions, the pilot must delay the final decision to continue or to go-around until a very low point on the approach. This cannot be avoided. However, accurately predicting when the transition will take place will alleviate the problem. A recent actual weather flight investigation of a new weather measuring system, which Sperry and the Weather Bureau conducted, indicates that cockpit weather can be predicted. This system takes into account the effects of visual aids upon cockpit visibility.

A general limitation to the low-approach problem is the inadequacy of quantitative vertical positional information when the aircraft is below 200 feet. The glide slope at 200 feet and below ceases to be straight and the pilot no longer can determine with certainty whether the aircraft is proceeding away from the glide slope by virtue of a maneuver, or the glide slope is moving away from the aircraft which is maintaining a straight flight path. In the same vein the current barometric altimeters cease to be adequate for determining height. For minimum quantitative accuracy in this case, an instrument should not possess greater than a 10% error. This means that accuracy of an altimeter at 100 feet should be within 10 feet. It is these limitations of accuracy of the glide slope and height indication which limit the acceptable heights to which the aircraft can descend using either the automatic or flight director approach. This condition indicates that a transition to visual flight is still a requirement with automatic and flight director systems.

The use of an instrument landing system which is capable of considerably tighter tolerances than is available with today's ILS, could make use of the great stability of the flight director and automatic approach couplers to couple the aircraft to the system to appreciably lower altitudes. The RTCA has specified the requirements for such systems which would permit automatic control of the aircraft to a height of 50 feet above the runway. The use of a precise localizer and glide slope also would provide the necessary positional information to the pilot on the approach. However, some independent indication of height with the same degree of precision is required to cover the missed-approach procedure.

A requirement exists for the pilot to be able to predict the position of his aircraft a few seconds in the future on the low approach. In order to accomplish this, the aircraft must be in steady and unaccelerated flight, *i.e.*, in straight flight and at constant speed. Any oscillatory or unstable motions of the aircraft seriously reduce the ability of the pilot to predict what the instruments will read a few seconds in the future. Only the automatic approach or the flight director can provide the necessary performance under the range of disturbances encountered to permit the pilot to make his assessment.

In the low instrument approach which is being done by automatic or flight-director systems, visual reference to approach lights greatly supports the height instrumentation. This is not to say that it is necessary for sufficient visual reference to exist on the approach lights to enable the pilot to control the aircraft visually. Positional information in terms of height and displacement is possible through the presence of only a few approach lights. If on a low approach these lights become visible at 200 feet, they

(*Continued on page* 41)

Ed. Note—From time to time, SKYWAYS will publish official CAB Accident Reports. True facts and figures regarding these mishaps serve to emphasize the need for vigilance in safe and efficient maintenance and operation of aircraft. We believe pilots, professional or non-professional, are interested in these official reports and can profit by them.

The Accident

A Lockheed model 18-56 *Lodestar*, N 9201H, owned by John Fox, publisher of the Boston *Post*, crashed nine miles southeast of Glastonbury, Conn., No. 5, 1954, at approximately 1942 (EST). Of the five persons on board, the copilot was killed, the pilot seriously injured, and the three passengers received minor injuries. The aircraft was destroyed by impact and fire.

Flight History

At approximately 1845, Nov. 5, N 9201H departed LAG, New York, on a VFR flight to Logan Airport, Boston. Crew consisted of Capt. J. K. MacKenzie and Copilot W. H. Welch. Passengers were Robert W. Mudge, Raymond J. Halloran, both airline pilots, and Mathew C. Abbott, an electrical engineer. Climbing to an altitude of 3500 ft m sl, the flight proceeded toward Boston.

Approximately 12 miles southeast of Hartford, Conn., the right engine became very rough and backfired frequently. The captain was unable to correct this condition and later feathered the right propeller when in the vicinity of Willimantic, Conn. A wide right turn was made from a northeasterly to a northwesterly heading toward Bradley Field, Windsor Locks. Communication was established with Bradley Field and the flight was cleared for a straight-in approach to Runway 33.

The aircraft descended to 2500 ft m sl during the turn and thereafter continued descending on a northwest heading until it struck trees and crashed.

The Bradley Field 1930 weather was: Scattered clouds at 4500 ft, visibility 15 mi plus, temperature 40°, dewpoint 32, wind northwest 6 mph. LAG weather at the time of departure was: Ceiling unlimited, visibility 15 mi plus. Conditions enroute were clear with excellent visibility.

Investigation

The accident occurred approximately nine miles SSE of Glastonbury, and approximately 25 miles SSE of Bradley Field. When N 9201H struck the tops of the trees, it was on a northwesterly heading and in a descending right-wing-low attitude. Initial ground contact was at 705 ft m sl and about 500 ft from the first trees struck by the aircraft. The right wing tip struck first, then the right engine, nose of the aircraft, and left engine, followed by a 180° rotation of the aircraft to the right and a short skid rearward. Crew members and one passenger were thrown out of the aircraft. The other two passengers, with the help of the passenger who had been thrown clear, were forced to break the window of the jammed emergency exit in order to leave the aircraft.

While enroute, Capt. MacKenzie had invited the airline pilot-passengers to the cockpit to observe the flight operation. Mr. Mudge came forward first and noted during his visit that the aircraft was at 3500 ft m sl on a heading of approximately 65° with an IAS of 190 mph, 28″ manifold pressure, and 1900 rpm; mixture controls were in auto-lean position with some left engine carburetor heat.

Shortly before the engine difficulty began, Mr. Halloran went forward, took the left seat, and watched while Copilot Welch flew the aircraft. When the engine roughness developed, Capt. MacKenzie who was then in the cabin, immediately went forward, and took the left seat and control of the aircraft. Mr. Halloran returned to the cabin. The right propeller was feathered after efforts to smooth the engine failed. Left engine and propeller controls were advanced to 31″ manifold pressure and 2100 rpm with full rich mixture and no carburetor heat. Small advances of engine and propeller controls were made on the operative engine during the descending right turn and the last increase was to 36-37″ manifold pressure and 2300 rpm. This last advance was made at 1500 ft m sl, but it gave no noticeable improved flight performance. Capt. MacKenzie testified to this sequence of events.

Mr. Mudge testified that he had moved to a position behind the crew and noted that the heading on the directional gyro was 300° and that the aircraft was at an altitude of 2500 ft, descending at a rate of 200 or 300 fpm. Also, the manifold pressure was 32″ and the airspeed, 140 mph. At this time the town of Willimantic was a few miles to the right. The copilot acted upon the suggestion of Mr. Mudge and tuned one ADF receiver to the Hartford LFR station. He was also advised of a field (Rentschler) just beyond the station. Capt. MacKenzie agreed to the suggestion.

When Mr. Mudge noted an altitude of only 950 ft (250 ft above the ground) and an IAS of 95 mph, he "ran" to the cabin and took a rearward facing seat, realizing the crash was imminent.

Both engines were torn from the airframe and the aircraft nose section was demolished during impact. Although no witness observed fire in either engine on the ground, there was evidence of a small flash fire near the left engine. Sections of the right wing were found scattered beyond the main wreckage area. Fire destroyed the fuselage and the right wing. All survivors testified that there was no evidence of fire in flight nor failure or malfunction of controls prior to impact.

Disassembly and examination of the two propellers revealed that the approximate blade angles of the left propeller were 25° and the right propeller blade angles were 78°, this latter being near the full-feathered position. There was no indication of mechanical failure or malfunctioning of the two propellers or their control assemblies.

Disassembly of the right engine revealed that the rear throw clamping surface and the mating surface of the crank pin were severely galled and fretted from looseness and shifting of the crankcase. Rollers and roller retainers of the main bearing were mutilated. The power section was severely damaged with all pistons either lodged in the heads of the cylinders or broken up and found in the power section.

Disassembly of the left engine revealed evidence that the cylinders, pistons, and valves had been operated at above normal temperatures. No. 1 cylinder exhaust valve was excessively burned; the guide and boss were missing and the bent valve stem and weakened valve spring gave evidence of excessive operating temperatures.

An airbox test of the carburetors revealed an abnormally lean mixture in the one for the left engine. Pilots and mechanics who had operated the engines stated it had been necessary to use carburetor heat for left engine smoothness. A flow bench test of the left carburetor revealed a normal fuel flow. Disassembly of the left carburetor AMC revealed that the needle was extended beyond its normal position causing a lean mixture. A slight melting of the solder on the top of the AMC bellows was noted.

The aircraft and engine logs were destroyed by the fire. The surplus engines installed on different dates in N 9201H were not supplied with logs when they were purchased "as is." The true amount of time on the engines since overhaul is unknown and cannot be determined. The engines were logged as zero time since overhaul after a partial teardown and inspection was made following their purchase. Since then the left and right engines had 479 and 170 hours, respectively, at the time of the accident.

The gross weight of N 9201H at takeoff has been computed at 17,970 lbs, which is 530 lbs under the maximum allowable gross weight of 18,500 lbs. Fuel consumed during the flight to Glastonbury reduced the gross weight approximately 500 lbs.

Capt. MacKenzie had flown approximately four years as copilot on the subject aircraft and one year as pilot in command. His command-pilot time on the aircraft was about 200 hours. He stated, as did the former pilot in command of N 9201H, that they had simulated single-engine flight on several occasions. His record also reflects that he was either pilot or copilot on Lockheed aircraft during numerous ferry flights across the north Atlantic during World War II. It was testified that Copilot Welch had two short periods of employment as a copilot on DC-3 equipment before his employment as the Fox *Lodestar* copilot.

Analysis

The Lockheed Aircraft Corp. operating instructions for *Lodestars* state under the heading, "Single-engine Emergency Operation: In the event of failure of one engine in climb, cruise or descent, there is seldom need for maximum power from the operative engine unless the airspeed has decreased below approximately 90 mph. (a) Set the mixture control in the auto-rich position, the propellers to give 2500 rpm, and adjust the throttle to give a manifold pressure varying from 41.8″ at sl to 37.3″ at 6900 ft. . . .(b) Feather the inoperative propeller and set the mixture control in idle-cutoff. (c) Set the carburetor heat adjustment to cold unless icing conditions exists. (d) Trim the airplane with rudder tab control. (e) Turn fuel system engine

selector valve to operating engine only. (f) Correct selector for vacuum pump and turn and bank. (g) Reduce the manifold pressure to give low power output as is consistent with safe operation."

This same instruction manual under "General Flight Data" states that "at 17,500 lbs the single-engine ceiling is 16,300 ft and the IAS for maximum rate of climb, one engine, sl, is 117 mph."

Further, it is an accepted practice for a pilot, with an engine out, to immediately use rated power on the remaining engine until single-engine flight with minimum loss of altitude is established. Power can then be reduced to optimum aircraft performance. As testified to by the pilot and an observing passenger, power was only increased by small increments during the entire loss of altitude and airspeed. Even the last increase, immediately prior to the crash, was only to a power setting considerably below the initial setting specified for single-engine operation in the Lockheed manual. Had the accepted technique been used, it is believed the aircraft could have been flown to an available airport.

It is apparent that there was ample opportunity for the captain to have become thoroughly familiar with correct single-engine procedure on this aircraft.

The condition of the right engine rear throw clamping surface indicated some fault in the installation of this part at a time prior to purchase of the engine.

The condition of the left engine as revealed by disassembly indicates that there was available to the pilot less than normal power at all settings. Although the left engine was not developing normal power for each power setting, it is believed there was sufficient power remaining so that flight could have been maintained had the pilot used accepted single-engine procedures.

Had the pilot made a different turn at the time of the engine failure, the resultant shorter distance might have enabled the aircraft to have safely reached Bradley Field despite the consistent loss of altitude.

Although a thousand feet of altitude was unnecessarily lost during the initial part of the emergency, there was still sufficient time and altitude to establish correct single-engine performance. This was borne out by the fact that when the northwest heading was established, the aircraft was still at 2500 ft and descending at only 200-300 fpm. This rate of descent continued down to 200 ft above the ground at which time the IAS was only 95 mph.

Findings

1. The crew and the aircraft were properly certificated.
2. There was no fire prior to impact.
3. Weather was not a factor in the accident.
4. A structural failure occurred in the power section of the right engine that necessitated feathering of the right propeller.
5. Failure to attain single-engine performance resulted in loss of altitude.
6. Mechanical difficulties in the left engine reduced power but remaining available power was sufficient for single-engine performance.

Probable Cause

The CAB determines that the probable cause of this accident was that after failure of the right engine, accepted single-engine procedure was not followed, which resulted in the aircraft losing altitude and striking the ground.

/s/ By the Civil Aeronautics Board

Supplemental Data

The Aircraft: Last certificate of airworthiness was issued Feb. 12, 1954. The aircraft was converted from a Navy R5-0-5 to a Lockheed Lodestar, model 18-56, January 23, 1947. Total aircraft time at that date was approximately 1500 hours. The Wright R1820-60 engines installed at the conversion were replaced, after accumulating about 1000 hours each, by Navy surplus engines of the same type. At the time of the accident, the left engine had about 479 logged hours; the right engine, about 170 logged hours. Propellers were Hamilton Standard model 23E50-471.

All Weather *(Cont. from 39)*

become available to the pilot at the time when the accuracy of the glide slope indication and the altimeter begin to deteriorate. This is a significant benefit of approach lights to the automatic or flight-director approach when accomplished under very low visibility conditions.

Substantial reductions in operating minima are dependent upon the implementation of new and as yet unavailable types of airborne instrumentation and ground equipment. The question that might be asked at this point is, "Will the automatic approach or the flight director with the present ILS provide lower minima than are now in use?" The answer is, "Yes, but not much lower."

The minimum is defined as the lowest height to which a pilot can descend without visual reference. In the following, we assume that visual reference is not obtained until this height is reached.

The establishment of a minimum should be based on two factors: 1) an acceptable value of approach success which is predicated primarily on economic considerations, and 2) an assumed value of risk which is considered acceptable for the over-all operation. Now, if a 200-foot descent minimum is assumed (and remembering that visual reference is obtained at this height and *not before*), either the automatic approach or the flight-director system will provide a significantly higher percentage of completed landings, *i.e.*, a higher degree of approach success, than will a manual system in which pure attitude displays are used in conjunction with an ILS indication. The risk wll be reduced because the visual maneuvering required at the end of the approach is less. In addition, the risk also will be reduced in the event of a go-around caused by the absence of visual reference at the minimum since the greater stability of the automatic and flight director coupling systems provide a better starting point for a missed approach procedure. Finally, since the approach success is higher and the risk is less, the automatic or flight director minimum logically could be reduced below the manual minimum. However, the risk of the go-around increases rapidly as the minimum is reduced. This is the factor which presently prevents lowering the minimum to a value which might appear feasible based on the approach success alone. If the minimum altitude is to be reduced while maintaining the acceptable risk value, the flight path control during the go-around must be markedly improved. A good standard of performance for the missed approach would be where the aircraft could be taken around from landing configuration and speed at a height of 50 feet from the runway with the same precision that can be accomplished visually.

Writer's opinion, operation achieved by:

1. Automatic or flight director coupling to the ILS is used.
2. The ILS is made more precise, especially the glide slope.
3. Present accepted high-intensity approach and runway lights are installed.
4. A "cockpit weather" predicting system is implemented.
5. A more precise absolute height indication is provided in the cockpit.
6. Flight path control during a go-around can be so precise as to eliminate the present risk associated with maneuver.

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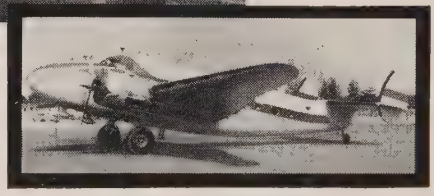

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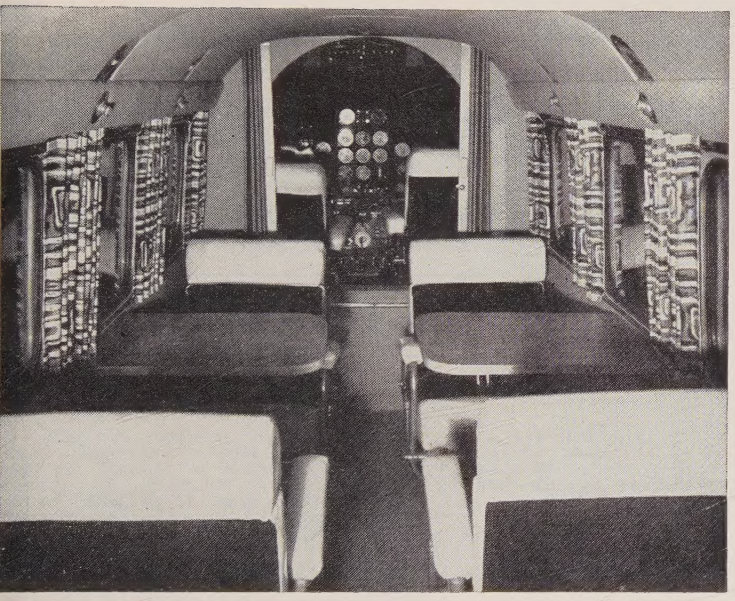

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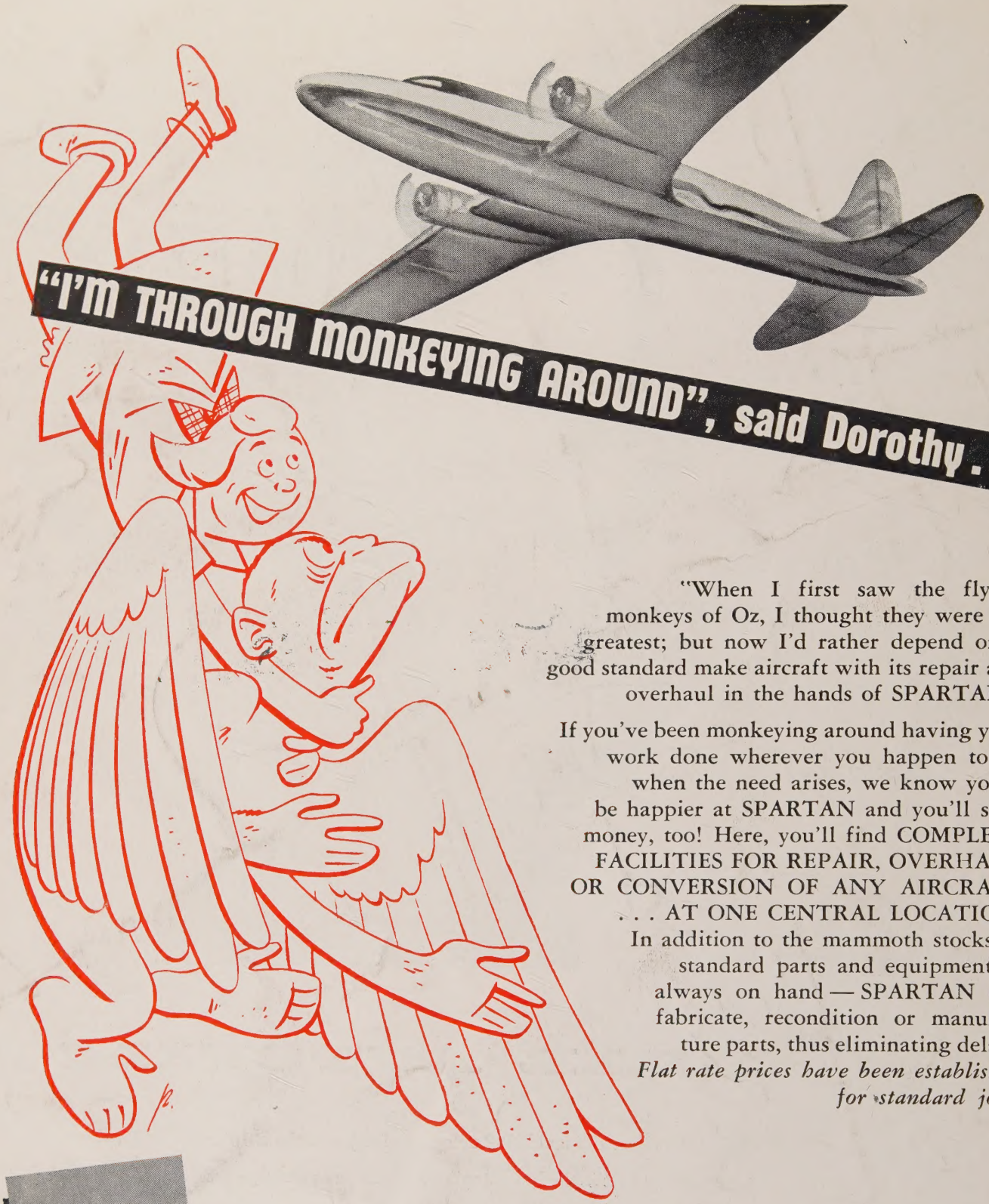

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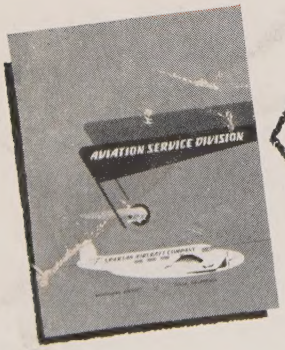

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